Management of Temporomandibular Disorders

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30

CHAPTER

CHAPTER OUTLINE

Patients frequently consult a dentist because of pain or dysfunction in the temporomandibular region. The most common causes of temporomandibular disorders (TMDs) are muscular disorders, which are commonly referred to as *myofascial pain and dysfunction.* These muscular disorders are generally managed well with a variety of reversible nonsurgical treatment methods.

Other causes of temporomandibular pain or dysfunction originate primarily within the temporomandibular joint (TMJ). These causes include internal derangement and osteoarthritis, rheumatoid arthritis, chronic recurrent dislocation, ankylosis, neoplasia, and infection. Although some of these disorders will respond to nonsurgical therapy, some cases may eventually require surgical treatment. If a successful result is to be achieved, management of

these patients requires a coordinated plan between the general dentist, oral and maxillofacial surgeon, and other health care services.

EVALUATION

The evaluation of the patient with temporomandibular pain, dysfunction, or both is like that in any other diagnostic workup. This evaluation should include a thorough history, a physical examination of the masticatory system, and some type of routine TMJ radiography. Special diagnostic studies should be performed only as indicated and not as routine studies.

Interview

The patient's history may be the most important part of the evaluation, because it furnishes clues for the diagnosis. The history begins with the chief complaint, which is a statement of the patient's reasons for seeking consultation or treatment. The history of the present illness should be comprehensive, including an accurate description of the patient's symptoms, chronology of the symptoms, description of how the problem affects the patient, and information about any previous treatments (including the patient's response to those treatments).

Examination

The physical examination consists of an evaluation of the entire masticatory system. The head and neck should be inspected for soft tissue asymmetry or evidence of muscular hypertrophy. The patient should be observed for signs of jaw clenching or other habits. The masticatory muscles should be systematically examined. The muscles should be palpated for the presence of tenderness, fasciculations, spasm, or trigger points (Fig. 30-1).

The TMJs are examined for tenderness and noise (Fig. 30-2). The location of the joint tenderness (e.g., lateral, posterior) should be noted. If the joint is more painful during different areas of the opening cycle or with different types of functions, this should be recorded. The most common forms of joint noise are clicking (a distinct sound) and crepitus (i.e., multiple scraping or grating sounds). Many joint sounds can be easily heard without special instrumentation or can be felt during palpation of the joint. However in some cases auscultation with a stethoscope may allow less obvious joint sounds, such as mild crepitus, to be appreciated.

The mandibular range of motion should be determined. Normal range of movement of an adult's mandible is about 45 mm vertically (i.e., interincisally) and 10 mm protrusively and laterally (Fig. 30-3). The normal movement is straight and symmetric. In some cases tenderness in the joint or muscle areas may prevent opening. The clinician should attempt to ascertain not only the painless voluntary opening but also the maximum opening that can be achieved with gentle digital pressure. In some cases the patient may appear to have a mechanical obstruction in the joint causing limited opening but with gentle pressure may actually be able to achieve near normal opening. This may suggest muscular rather than intracapsular problems.

The dental evaluation is also important. Odontogenic sources of pain should be eliminated. The teeth should be examined for wear facets, soreness, and mobility, which may be evidence of bruxism. Although the significance of occlusal abnormalities is controversial, the occlusal relationship should be evaluated and documented. Missing teeth should be noted, and dental and skeletal classification should be determined. The clinician should note any centric relation and centric occlusion discrepancy or significant posturing by the patient. The examination findings can be summarized on a TMD evaluation form and included in the patient's chart. In many cases a more detailed chart note may be necessary to adequately document all of the history and examination findings described previously.

Radiographic Evaluation

Radiographs of the TMJ are extremely helpful in the diagnosis of intraarticular, osseous, and soft tissue pathology. The use of radiographs in the evaluation of the patient with TMD should be based on the patient's signs and symptoms instead of routinely ordering a "standard" set of radiographs. In many cases the panoramic radiograph provides adequate information as a screening radiograph in evaluation of TMD. A variety of other radiographic techniques are available that may provide useful information in certain cases.

Transcranial radiographs. A standard dental radiographic unit combined with a head-holding device can be used to produce a transcranial image of the TMJ. Although this view will not allow detailed examination of all aspects of the TMJ, excellent evaluation of the lateral pole of the condyle can be accomplished when the proper radiographic technique is used. Because bony pathology of the TMJ frequently extends to the lateral pole, this technique can be helpful in diagnosing bony internal joint pathology (Fig. 30-4).[1]

Panoramic radiography. One of the best overall radiographs for screening evaluation of the TMJs is the panoramic radiograph. This technique allows visualization of both TMJs on the same film. Because a panoramic technique provides a tomographic type of view of the TMJ, this can frequently provide a good assessment of the bony anatomy of the articulating surfaces of the mandibular condyle and glenoid fossa (Fig. 30-5), and other areas, such as the coronoid process, can also be visualized. Many machines are equipped to provide special views of the mandible, focusing primarily on the area of the TMJs. These radiographs can often be completed in both the open and closed position.

Tomograms. The tomographic technique allows a more detailed view of the TMJ.[2] This technique allows radiographic sectioning of the joint at different levels of the condyle and fossa complex, which provides individual views visualizing the joint in "slices" from the medial to the lateral pole (Fig. 30-6). These views eliminate bony superimposition and overlap and provide a relatively clear picture of the bony anatomy of the joint (see Fig. 30-6).

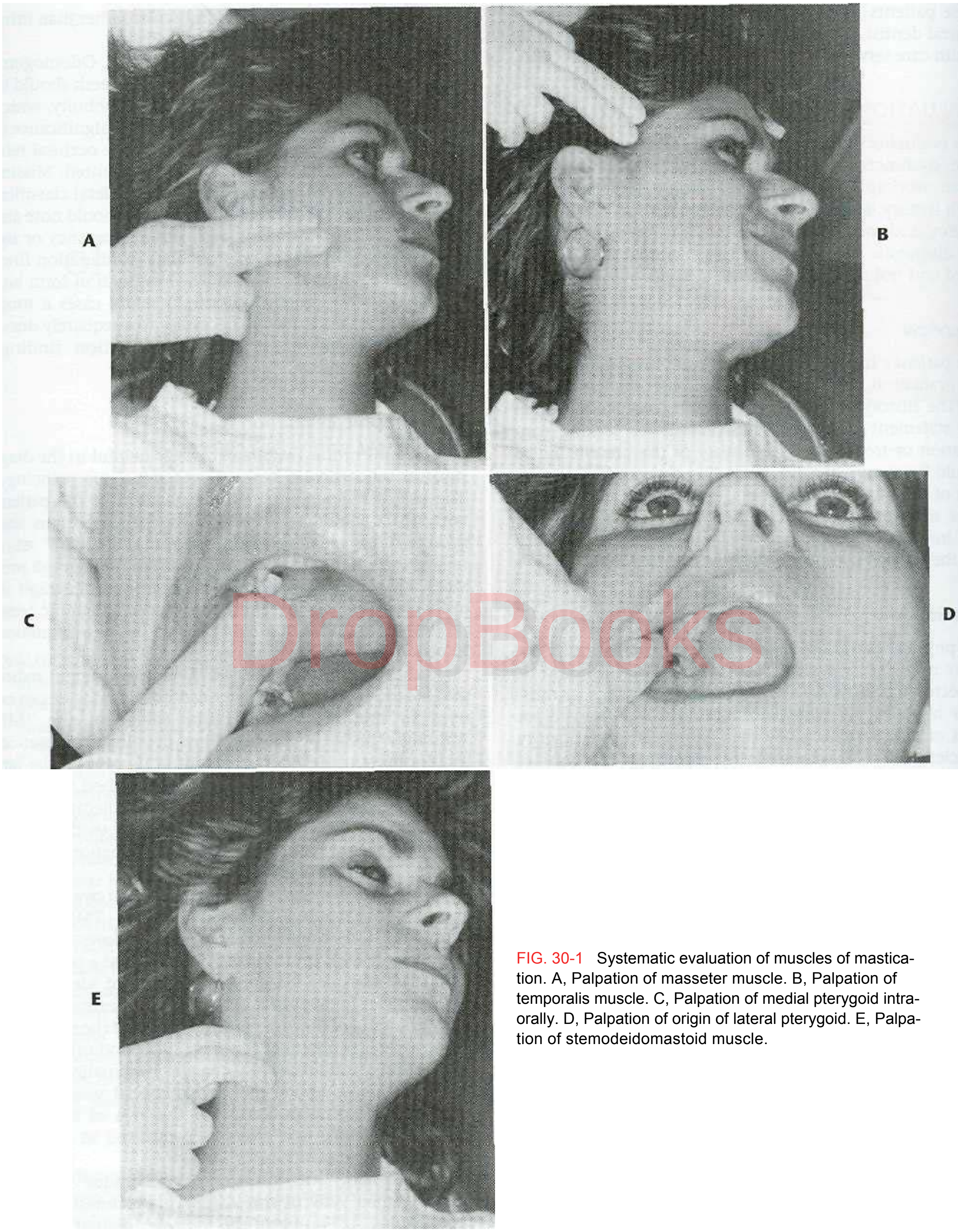


FIG. 30-1 Systematic evaluation of muscles of mastication. A, Palpation of masseter muscle. B, Palpation of temporalis muscle. C, Palpation of medial pterygoid intraorally. D, Palpation of origin of lateral pterygoid. E, Palpation of stemodeidomastoid muscle.

A B C D

FIG. 30-2 Evaluation of temporomandibular joint (TMJ) for tenderness and noise, joint is palpated laterally in closed position (A), open position (B), and through the external auditory canal in the closed position (C) and open position (D).

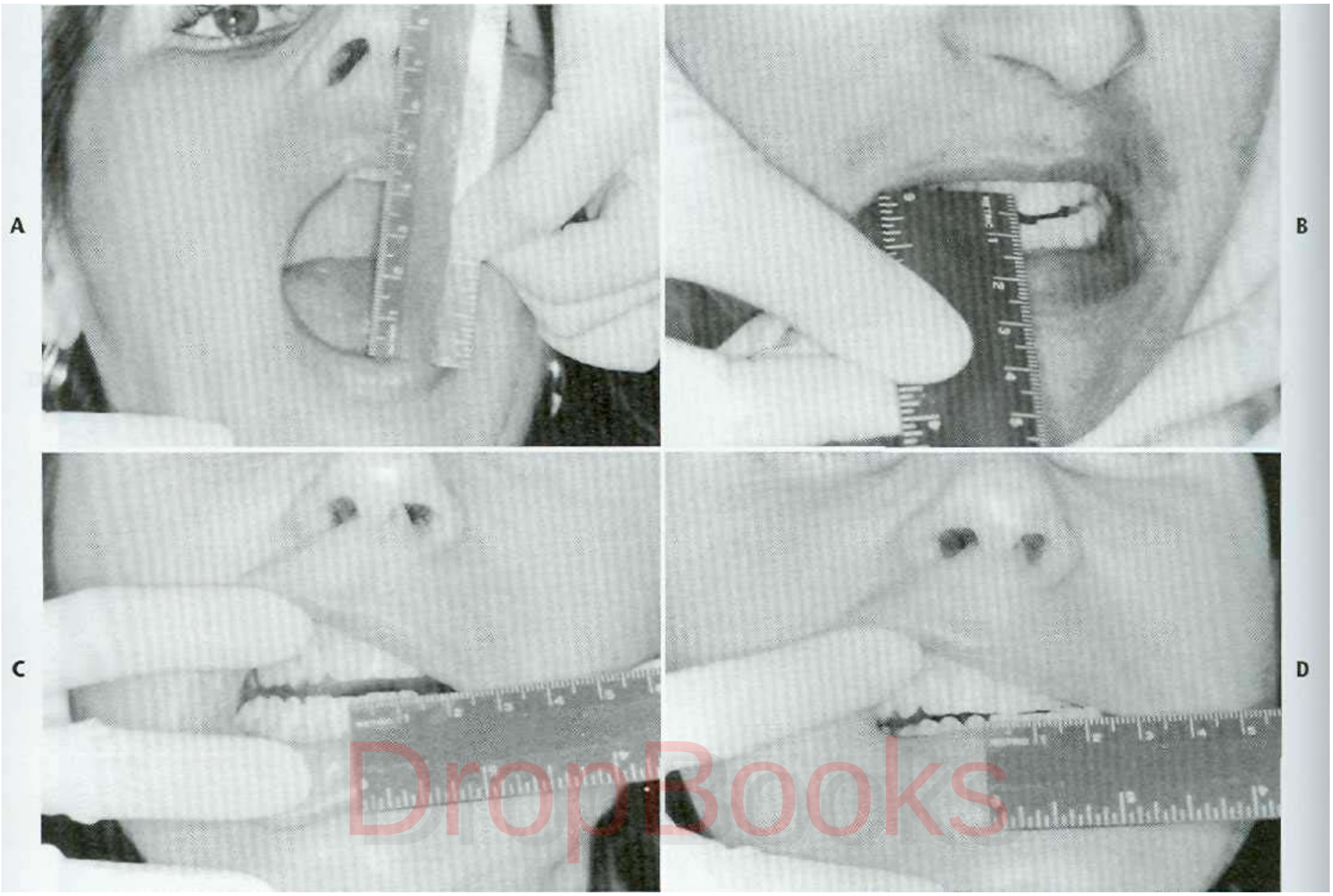


FIG. 30-3 Measurement of range of jaw motion. A, Maximum voluntary vertical opening (should be 45 mm or greater). B, Protrusion (should be approximately 10 mm). C and D, Left and right lateral excursions (should be approximately 10 mm).

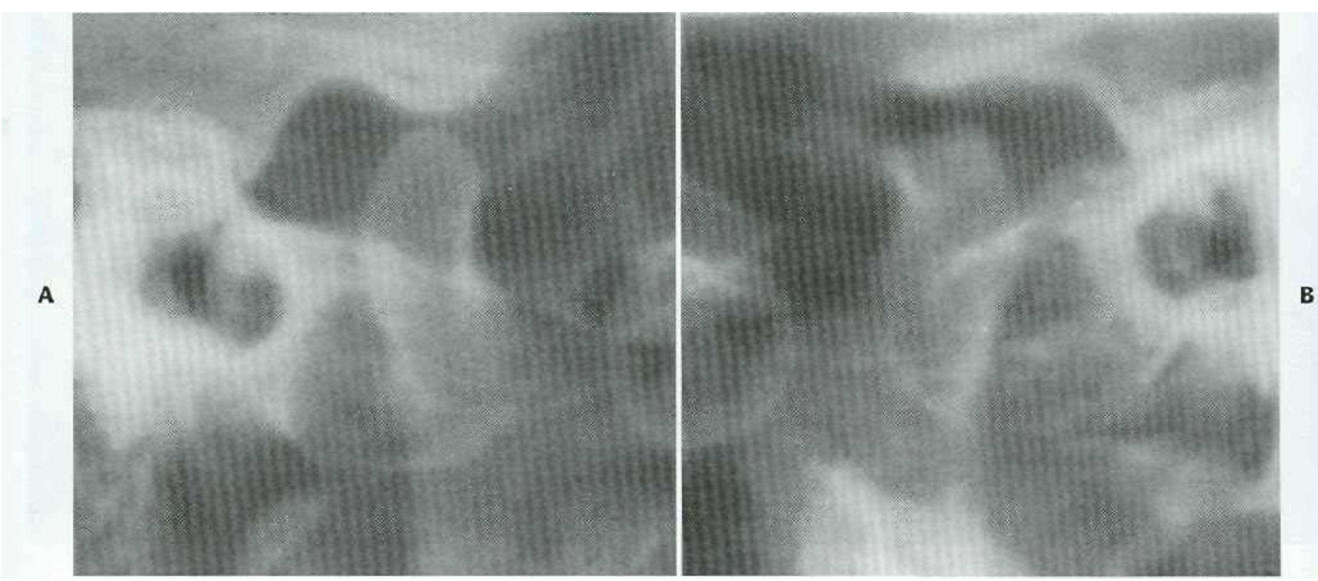


FIG. 30-4 Examples of transcranial radiographs. A, Radiograph of right side shows normal anatomy of fossa and condyle. B, Left-side view demonstrates degenerative changes of condyle.

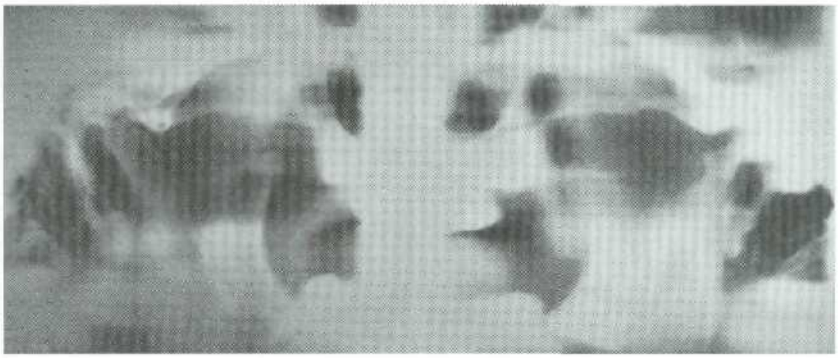


FIG. 30-5 Modified panoramic view demonstrates normal anatomy of right condyle and degenerative changes of left condyle. This modified panoramic radiographic technique shows increased detail of posterior ramus and condyle area while eliminating the anterior mandible from radiographic image.

Temporomandibular joint arthrography. This imaging method was the first technique available that allowed visualization (indirect) of the intraarticular disk.

Arthrography involves the injection of contrast material into the inferior or superior spaces of a joint, after which the joint is radiographed.-[3] Evaluation of the configuration of the dye in the joint spaces allows evaluation of the position and morphology of the articular disk (Fig. 30-7). This technique also demonstrates the presence of perforations and adhesions of the disk or its attachments. With the availability of more advanced, less invasive techniques arthrography is rarely used.

Computed tomography. Computed tomography (CT) provides a combination of tomographic views of the joint, combined with computer enhancement of hard and soft tissue images.[4] This technique allows evaluation of a variety of hard and soft tissue pathology in the joint. CT images provide the most accurate radiographic assessment of the bony components of the joint (Fig. 30-8). CT scan reconstruction capabilities allow images obtained in one plane of space to be reconstructed so that the images can be evaluated from a different view. Thus evaluation of the joint from a variety of perspectives can be made from a single radiation exposure.

Magnetic resonance imaging. The most effective diagnostic imaging technique to evaluate TMJ soft tissues is magnetic resonance imaging (MRI) (Fig. 30-9).[5] This technique allows excellent images of intraarticular soft tissue, making MRI a valuable technique for evaluating disk morphology and position. MRI images can be obtained showing dynamic joint function in a cinematic fashion, providing valuable information about the anatomical components of the joint during function. The fact that this technique does not use ionizing radiation is a significant advantage.

Nuclear imaging. This technique involves injection of Tc", a gamma-emitting isotope that is concentrated in areas of active bone metabolism. Approximately 3 hours after injection of the isotope, images are obtained using a gamma camera. Single photon emission computerized tomography (SPECT) images can then be used to determine active areas of bone metabolism (Fig. 30-10).[6]

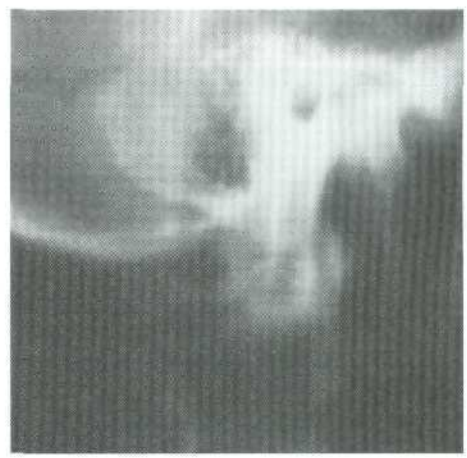


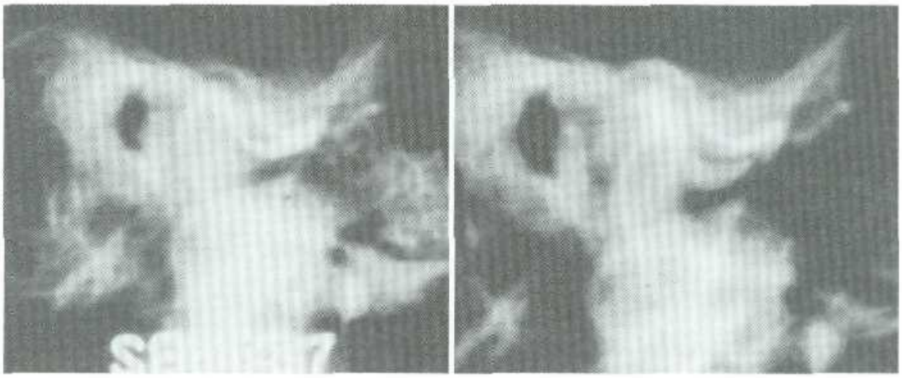
FIG. 30-6 Tomographic projection of temporomandibular joint demonstrates typical degenerative changes with loss of well-defined joint space, absence of cortical outline of condyle, and anterior condylar lipping.

Although this technique is extremely sensitive, the information obtained may be somewhat difficult to interpret. Because bone changes, such as degeneration, may appear identical to repair or regeneration, this technique must be evaluated cautiously and in combination with clinical findings.

Psychologic Evaluation

Many patients with temporomandibular pain and dysfunction of long-standing duration develop manifestations of chronic pain syndrome behavior. This complex may include gross exaggeration of symptoms and clinical depression.[7] To evaluate possible behavioral changes associated with pain and dysfunction, the history should include questions regarding functional limitation that results from the patient's symptoms. If the functional limitation appears to be excessive when compared with the patient's clinical signs or the patient appears to be clinically depressed, further psychologic evaluation may be warranted.[8]

A



B

FIG. 30-7 Arthrogram shows dye in inferior and superior joint spaces. Anatomy and location of disk is indirectly interpreted from dye pattern observed after injection of joint spaces above and below disk. This arthrogram demonstrates anterior disk displacement without reduction. A, Closed position. B, Open position.

A

B

C

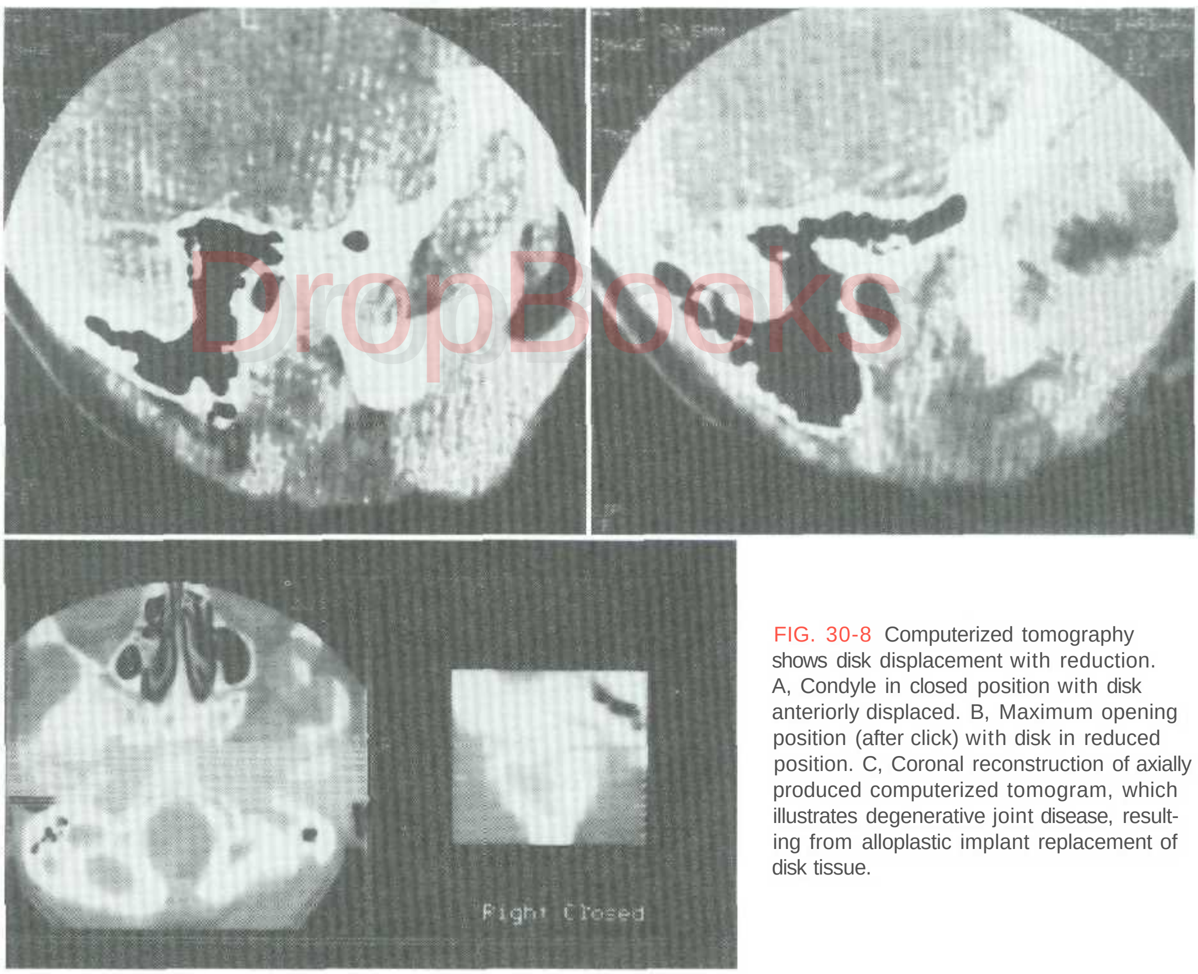


FIG. 30-8 Computerized tomography shows disk displacement with reduction. A, Condyle in closed position with disk anteriorly displaced. B, Maximum opening position (after click) with disk in reduced position. C, Coronal reconstruction of axially produced computerized tomogram, which illustrates degenerative joint disease, resulting from alloplastic implant replacement of disk tissue.

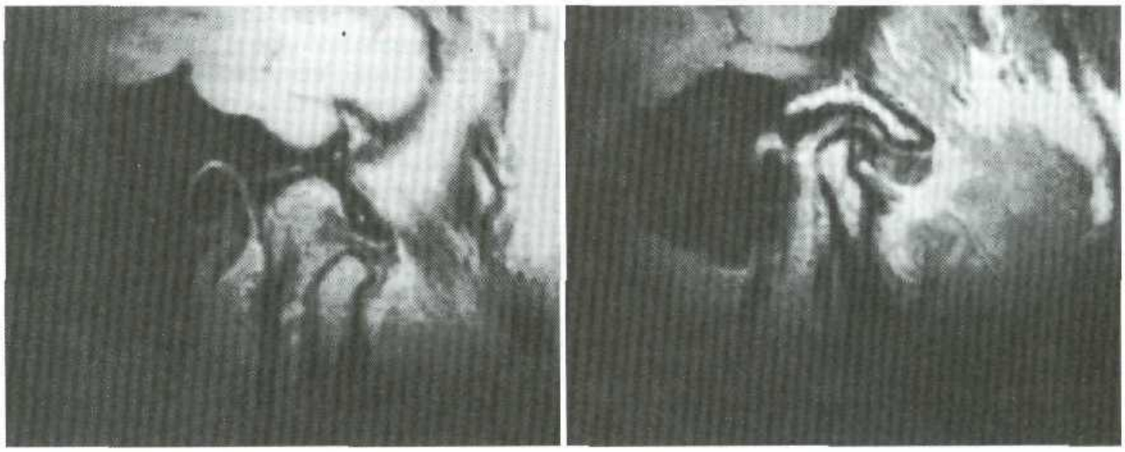


FIG. 30-9 Magnetic resonance image. A, This view shows normal disk and condyle relationship in open position. B, Image demonstrates anterior disk displacement and slight bone changes on articulating surface of condyle.

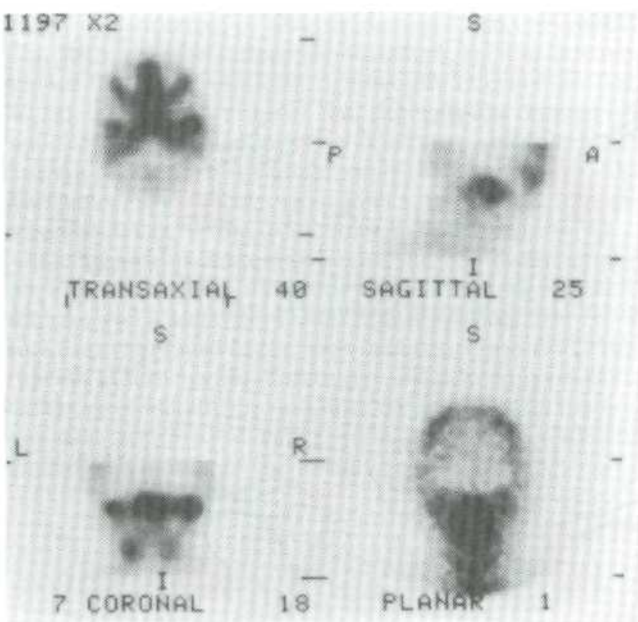


FIG. 30-10 Single photon emission computed tomography {bone scan). Area of increased activity is apparent in both temporomandibular joints.

CLASSIFICATION OF TEMPOROMANDIBULAR DISORDERS

Myofascial Pain

Myofasdal pain and dysfunction (MPD) is the most common cause of masticatory pain and limited function for which patients seek dental consultation and treatment. The source of the pain and dysfunction is muscular, with masticatory muscles developing tenderness and pain as a result of abnormal muscular function or hyperactivity. This abnormal muscular function is frequently but not always associated with daytime clenching or nocturnal bruxism. The cause of MPD is controversial, although it is generally considered to be multifactorial.[9] One of the most commonly accepted causes of MPD is bruxism secondary to stress and anxiety, with occlusion being a modifying or aggravating factor. MPD may also occur secondary to internal joint problems, such as disk displacement disorders or degenerative joint disease (DJD).

Patients with MPD generally complain of diffuse, poorly localized, preauricular pain that may also involve other muscles of mastication, such as the temporalis and medial pterygoid muscles. In patients with nocturnal bruxism, the pain is frequently more severe in the morning. Patients generally describe decreased jaw opening with pain during functions such as chewing. Headaches, usually hitemporal in location, may also be associated with these symptoms. Because of the role of stress, the pain is often more severe during periods of tension and anxiety.

Examination of the patient reveals diffuse tenderness of the masticatory muscles. The TMJs are frequently nontender to palpation. In isolated MPD, joint noises are usually not present. However, as mentioned previously, MPD may be associated with a variety of other joint problems that may produce other TMJ signs and symptoms. The range of mandibular movement in MPD patients may be decreased and is associated with deviation of the mandible toward the affected side. The teeth frequently have wear facets. However, the absence of such facets does not eliminate bruxism as a cause of the problem.

Radiographs of the TMJs are usually normal. Some patients have evidence of degenerative changes, such as altered surface contours, erosion, or osteophytes. These changes, however, may be secondary to or unassociated with the MPD problem.

Disk Displacement Disorders

In a normally functioning TMJ the condyle functions in both a hinge and a sliding fashion. During full opening the condyle not only rotates on a hinge axis but also translates forward to a position near the most inferior

portion of the articular eminence (Fig. 30-11). During function the biconcave disk remains interpositioned between the condyle and fossa, with the condyle remaining against the thin intermediate zone during all phases of opening and closing.

Anterior disk displacement with reduction. In anterior disk displacement the disk is positioned anterior and medial to the condyle in the closed position. During opening the condyle moves over the posterior band of the disk and eventually returns to the normal condyle and disk relationship, resting on the thin intermediate zone. During closing the condyle then slips posteriorly and rests on the retrodiscal tissue, with the disk returning to the anterior, medially displaced position (Fig. 30-12).

Examination of the patient usually reveals joint tenderness, and muscle tenderness may also exist. Joint noise (i.e., clicking) is commonly heard with opening, when the condyle moves from the area posterior to the disk into the thin concave area in the middle of the disk. In some cases clicking can be heard or palpated during the closing cycle. Maximal opening can be normal or slightly limited, with the click occurring during the opening movement. Anatomically the opening click corresponds to the disk reducing to a more normal position. The closing click (i.e., reciprocal click) corresponds to the disk failing to maintain its normal position between the condylar head and the articular eminence and slipping forward to the anteriorly displaced position. Crepitus may be present and is usually a result of articular movement across irregular surfaces.

The images obtained from plain TMJ radiography in patients with anterior disk displacement may be normal or may demonstrate slight bone abnormalities. MRI images usually demonstrate anterior displacement of the disk.

Anterior disk displacement ***without reduction.*** In this type of internal derangement the disk displacement cannot be reduced, and thus the condyle is unable to translate to its full anterior extent, which prevents maximal opening and causes deviation of the mandible to the affected side (Fig. 30-13).

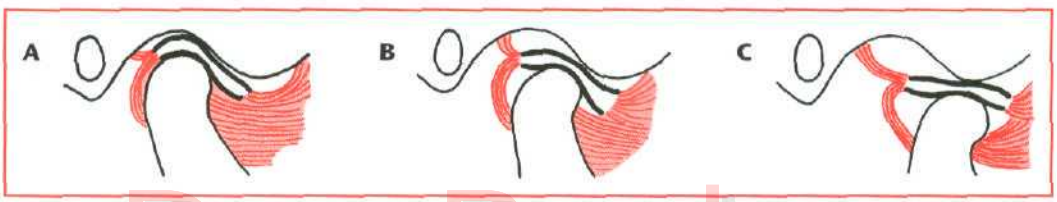


FIG. 30-11 Normal disk and condyle relationship. A, Biconcave disk is interpositioned between fossa and condyle in closed position. B, When condyle translates forward, thin intermediate zone stays in consistent relationship with condyle. C, Maximum open position.

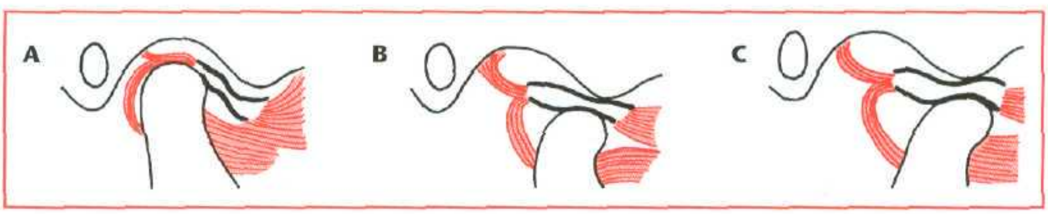


FIG. 30-12 Anterior disk displacement with reduction. A, Biconcave disk is situated anterior to articulating surface of condyle. When condyle translates forward, it eventually passes over thickened posterior band of disk, creating clicking noise. B, After click occurs, disk remains in appropriate relationship with condyle through remainder of opening cycle. C, Maximum opening position. When mandible closes, condyle and disk relationship will return to position as shown in A.

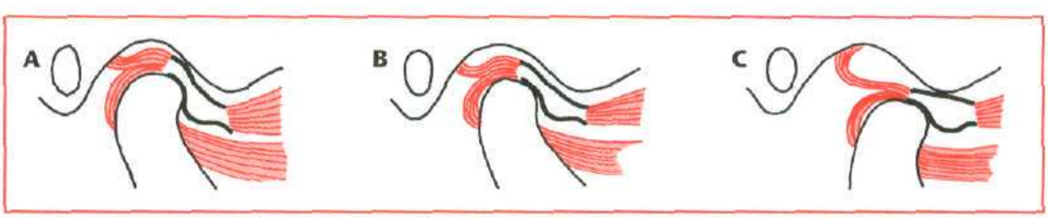


FIG. 30-13 Anterior disk displacement without reduction. A, Disk that has been chronically anteriorly displaced now has amorphous shape rather than distinct biconcave structure. B, When condyle begins to translate forward, disk remains anterior to condyle. C, In maximum open position, disk tissue continues to remain anterior to condyle, with posterior attachment tissue interposed between condyle and fossa.

In these patients no clicking occurs, because they are unable to translate the condyle over the posterior aspect of the disk. This lack of translation may result in restricted opening, deviation to the affected side, and decreased lateral excursions to the contralateral side. Some evidence suggests that the limitation of motion may not be directly related to the actual displacement of the disk but rather to the adherence of the disk to the fossa, causing a restriction of the sliding function of the joint.[10]

Radiographic evaluation of disk displacement without reduction is similar to findings in anterior disk displacement with reduction. Plain TMJ radiography may appear normal, whereas CT scans and MRIs generally demonstrate anteromedial disk displacement. However, in this disorder, images taken in the maximal open position continue to show anterior disk displacement within the open position.

Degenerative Joint Disease (Arthrosis, Osteoarthritis)

DJD includes a variety of anatomic findings, including irregular, perforated, or severely damaged disks in association with articular surface abnormalities, such as articular surface flattening, erosions, or osteophyte formation (Fig. 30-14). The mechanisms of TMJ degenerative diseases are not clearly understood but are thought to be multifactorial. Current concepts of DJD incorporate three possible mechanisms of injury: (1) direct mechanical trauma, (2) hypoxia reperfusion injury, and (3) neurogenic inflammation.[11]

Mechanical trauma may be a result of significant and obvious trauma to the joint or much less obvious microtrauma, such as excessive mechanical loading. The excessive stress produced in the joint can lead to molecular disruption and the generation of free radicals, with resulting oxidative stress and intracellular damage. Excess loading can also affect local cell populations and reduce the reparative capacity of the joint.

The hypoxia-reperfusion theory suggests that excessive intracapsular hydrostatic pressure within the TMJ may exceed the blood vessel perfusion pressure, resulting in hypoxia.

This type of increased intracapsular pressure has been clearly demonstrated in patients during clenching and bruxing.[12] When the pressure in the joint is decreased and perfusion is reestablished, free radicals are formed. These free radicals may interact with other substances in the joint (e.g., hemoglobin) to produce even more damage.

Neurogenic inflammation results when a variety of substances are released from peripheral neurons. It is hypothesized that in cases of disk displacement the compression or stretching of the nerve-rich retrodiscal tissue may result in release of proinflammatory neuropeptides.[11,13] The release of cytokines results in the release and activation of a variety of substances including prostaglandins, leukotrienes, and matrix-degrading enzymes. These compounds not only have a role in the disease process but also may serve as biologic markers that may help to diagnose and eventually treat joint pathology.[14,15] It must be emphasized that it is impossible to predict the progression of joint pathology.

Patients with DJD frequently experience pain associated with clicking or crepitus, located directly over the TMJ. Usually, an obvious limitation of opening is present, and symptoms usually increase with function. Radiographic findings are variable but generally exhibit decreased joint space, surface erosions, osteophytes, and flattening of the condylar head. Irregularities in the fossa and articular eminence may also be present.

Systemic Arthritic Conditions

A variety of systemic arthritic conditions are known to affect the TMJ. The most common of these is rheumatoid arthritis. Other processes, such as systemic lupus, can also

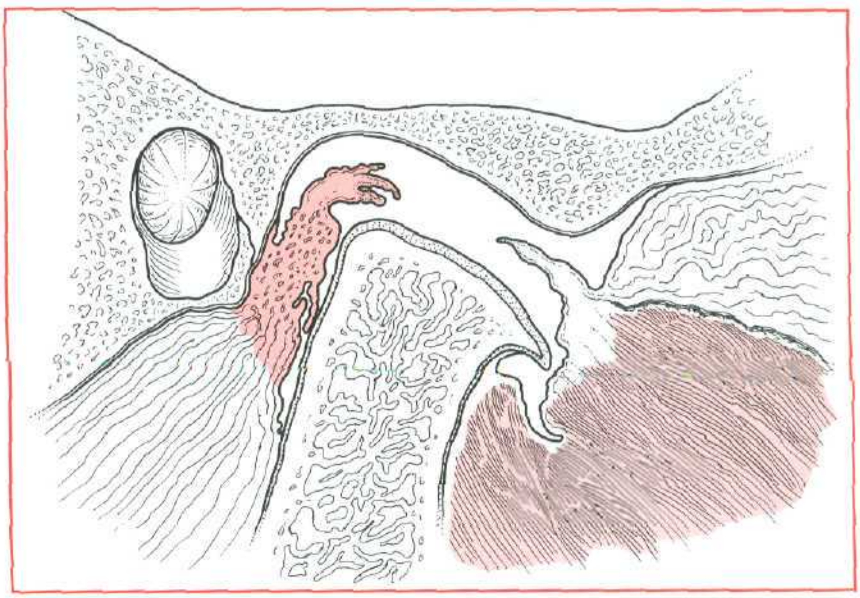


FIG. 30-14 Degenerative joint disease demonstrates large perforation of disk tissue and erosion and flattening of articulating surfaces of both condyle and fossa.

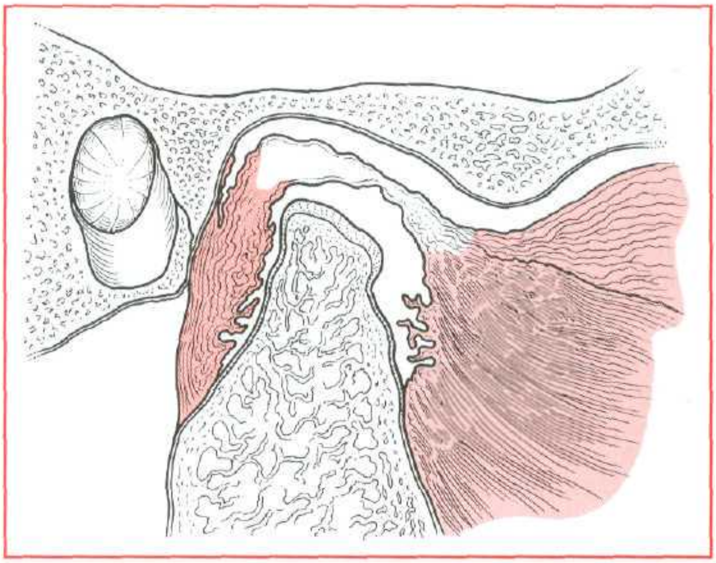


FIG. 30-15 Changes seen in rheumatoid arthritis of temporomandibular joint. These changes include proliferation of synovial tissue, creating resorption in anterior and posterior areas of condyle. Irregularities of disk tissue and articulating surface of condyle eventually occur.

FIG. 30-16 Anatomic specimen demonstrating dislocation of condyle in front of eminence. *EAC,* External auditory canal.

affect the TMJ. In these cases symptoms are rarely isolated to the TMJs, and several other signs and symptoms of arthritis are usually present in other areas of the body.

In the case of rheumatoid arthritis, an inflammatory process results in abnormal proliferation of synovial tissue in a so-called pannus formation (Fig. 30-15).

TMJ symptoms that result from rheumatoid arthritis may occur at an earlier age than those associated with DJD. As opposed to DJD, which is usually unilateral, rheumatoid arthritis (and other systemic conditions) usually affects the TMJs bilaterally.

Radiographic findings of the TMJ initially show erosive changes in the anterior and posterior aspects of the condylar heads. These changes may progress to large eroded areas that leave the appearance of a small, pointed condyle in a large fossa. Eventually the entire condyle and condylar neck may be destroyed. Laboratory tests, such as rheumatoid factor and erythrocyte sedimentation rate, may be helpful in confirming the diagnosis of rheumatoid arthritis.

Chronic Recurrent Dislocation

Dislocation of the TMJ occurs frequently and is caused by mandibular hypermobility. Subluxation is a displacement of the condyle, which is self-reducing and generally requires no medical management. A more serious condition occurs when the mandibular condyle translates ante-

riorly in front of the articular eminence and becomes locked in that position (Fig. 30-16). Dislocation may be unilateral or bilateral and may occur spontaneously after opening the mouth widely, such as when yawning, eating, or during a dental procedure. Dislocation of the mandibular condyle that persists for more than a few seconds generally becomes painful and is often associated with severe muscular spasms.

Dislocations should be reduced as soon as possible. This reduction is accomplished by applying downward pressure on the posterior teeth and upward pressure on the chin, accompanied by posterior displacement of the mandible. Usually reduction is not difficult. However, muscular spasms may prevent simple reduction, particularly when the dislocation cannot be reduced immediately. In these cases, anesthesia of the auricular temporal nerve and the muscles of mastication may be necessary. Sedation to reduce patient anxiety and provide muscular relaxation may also be required. After reduction the patient should be instructed to restrict mandibular opening for 2 to 4 weeks. Moist heat and nonsteriodal antiinflammatory drugs (NSAIDs) are also helpful in controlling pain and inflammation.

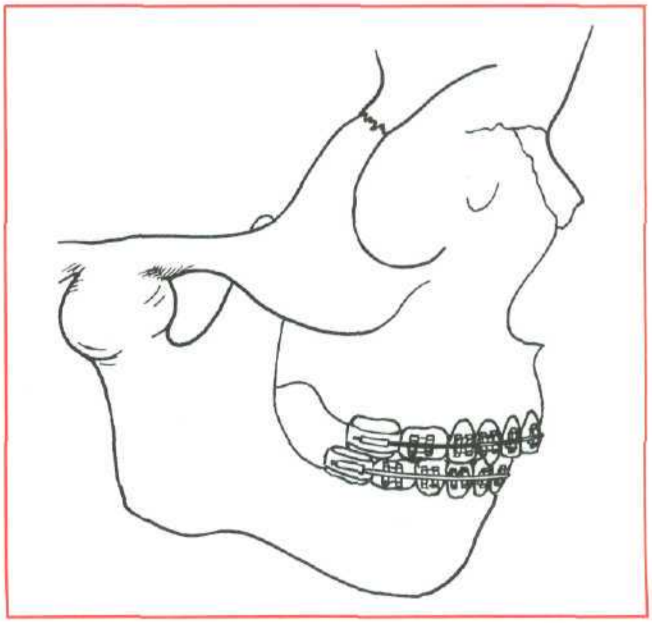


FIG. 30-17 Bony ankylosis. Diagram represents complete bone fusion of condyle process and glenoid fossa area.

Ankylosis

Intracapsular ankylosis. Intracapsular ankylosis, or fusion of the joint, leads to reduced mandibular opening that ranges from partial reduction in function to complete immobility of the jaw. Intracapsular ankylosis results from a fusion of the condyle, disk, and fossa complex, as a result of the formation of fibrous tissue, bone fusion, or a combination of the two (Fig. 30-17). The most common cause of ankylosis involves macrotrauma, most frequently associated with condylar fractures. Other causes of ankylosis include previous surgical treatment that resulted in scarring and, in very rare cases, infections.

Evaluation of the patient reveals severe restriction of maximal opening, deviation to the affected side, and decreased lateral excursions to the contralateral side. If the ankylosis is the result primarily of fibrous tissue, jaw mobility will be greater than if the ankylosis is a result of bone fusion.

Radiographic evaluation reveals irregular articular surfaces of the condyle and fossa, with varying degrees of calcified connection between these articulating surfaces.

Extracapsular ankylosis. This type of ankylosis usually involves the coronoid process and temporalis muscle. Frequent causes of extracapsular ankylosis are coronoid process enlargement, or hyperplasia, and trauma to the zygomatic arch area. Infection around the temporalis muscle may also produce extracapsular ankylosis.

Patients initially have limitation of opening and deviation to the affected side. In these cases, complete restriction of opening is extremely rare, and limited lateral and protrusive movements can usually be performed indicating no intracapsular ankylosis. Panoramic radiography generally demonstrates the elongation of a coronoid process. A submental vertex radiograph may be useful in demonstrating impingement caused by a fractured zygomatic arch or zygomaticomaxillary complex.

Neoplasia

Neoplasms in the TMJ are extremely rare. They can occasionally result in restriction of opening and joint pain. Tumors within the TMJ may result in an abnormal condyle and fossa relationship or an intracapsular ankylosis. A complete discussion of the neoplastic processes known to occur in the TMJ area is beyond the scope of this chapter.

Infections

Infections in the TMJ area are extremely rare, even in the case of trauma or surgical intervention in this area. In third world countries where antibiotic therapy of middle ear infections is not available, extension of infectious processes may occasionally involve the TMJ and result in intracapsular ankylosis.

REVERSIBLE TREATMENT

Although the cause of temporomandibular pain and dysfunction can arise from several different sources, initial treatment is frequently aimed at nonsurgical methods of reducing pain and discomfort, decreasing inflammation in muscles and joints, and improving jaw function. In some cases, such as ankylosis or severe joint degeneration, surgical treatment may be the preferred initial course of therapy. However, in most cases, including MPD, disk displacement disorders, and degenerative and systemic arthritic disorders, a nonsurgical, reversible treatment phase may provide significant reduction in

pain and improvement in function. In fact, most patients with MPD and internal derangements do extremely well without any type of long-term or invasive treatment. In the case of anterior disk displacement without reduction (i.e., closed lock), most patients experience a gradual progression of increased opening and decreased discomfort without extensive treatment. This is apparently the result of physiologic and anatomic adaptation of tissue within the joint. It appears that in many patients the posterior attachment tissue undergoes fibrous adaptation and adequately serves as interpositioning tissue between the condyle and fossa.[16] This is often termed *pseudodisk adaptation* (Fig. 30-18). This pseudodisk formation, combined with other normal healing capabilities of joints, is most likely responsible for clinical improvement in many patients.

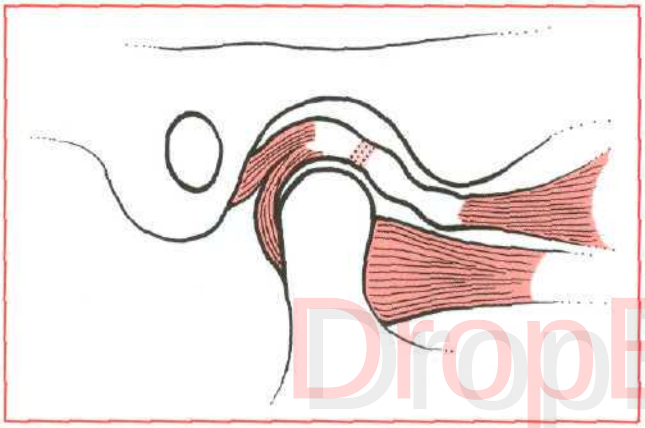


FIG. 30-18 Pseudodisk adaptation. When disk becomes anteriorly displaced, retrodiscal tissue undergoes fibrous adaptation, producing functional, although anatomically different, interpositional disk.

Patient Education

The first step in involving patients in their own treatment is to make them aware of the pathology producing their pain and dysfunction and to describe the prognosis or possible progression of their pain and dysfunction. Many problems of masticatory pain and dysfunction stabilize or improve with conservative therapy, despite patients' concerns that they may be on a continually deteriorating course. In the case of a patient with MPD, a precise, confident explanation should attempt to assure the patient that muscular pain usually improves with minimal treatment. The clinician should also explain that although symptoms may recur on occasion, they generally can be controlled with the treatment (described later in this chapter).

In some cases, such as DJD, the patient should be made aware of the long-term spectrum of outcomes of this problem. Warning signs of further deterioration, including increased pain, limitation of motion, and increased joint noise, should be emphasized to the patient.

Patients who have an awareness of the factors associated with their pain and dysfunction can actively participate in their own improvement. Myofascial pain often results from parafunctional habits or muscular hyperactivity secondary to stress and anxiety. Patients who are aware of these factors are often able to control their activity and thereby reduce discomfort and improve function. Biofeedback devices provide information to patients to help them control their muscular activity. For example, the output from surface electrodes over the masseter or temporalis muscle can be used to indicate clenching or grinding during daytime activity (Fig. 30-19).[17] Electromyographic (EMG) recordings can also be useful in evaluating nocturnal bruxism and associated pain and can be used to monitor the effectiveness of splint therapy and medication to control muscular hyperactivity. Other forms of stress control, such as physical exercise, reducing

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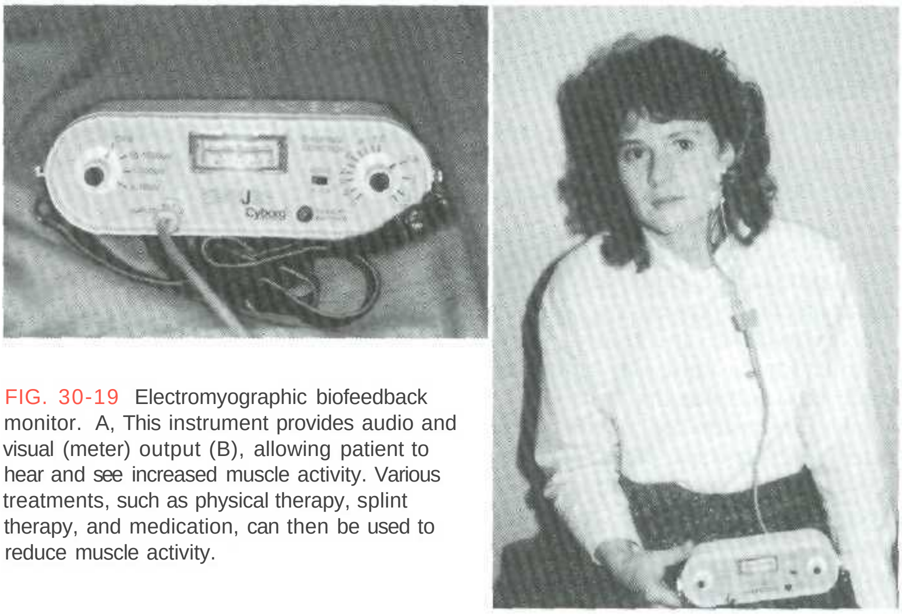


B

FIG. 30-19 Electromyographic biofeedback monitor. A, This instrument provides audio and visual (meter) output (B), allowing patient to hear and see increased muscle activity. Various treatments, such as physical therapy, splint therapy, and medication, can then be used to reduce muscle activity.

exposure to stressful situations, and psychologic counseling, can also be explored.

When the patient becomes aware of the relationship between personal actions and the symptoms of pain and dysfunction, behavior modification can follow.

Modification of diet and home exercise routines are also an important part of the patient's educational process. Patients who experience temporomandibular pain or dysfunction frequently find that it is most apparent when chewing hard food. Temporary alteration of the diet with nonchew, blenderized food may result in a significant reduction in symptoms. A gradual progression to a more normal diet over a period of 6 weeks may be sufficient to reduce joint or muscle symptoms.

Although the patient is generally encouraged to reduce the functional load placed on the joint and muscles, it is important to remember that maximizing range of motion is also an important aspect of treatment of all temporomandibular disorders. Home exercises may be helpful in maintaining normal function. These exercises include gentle stretching exercises done to pain tolerance through passive opening or active exercise routines. In some cases patients can obtain simple appliances that provide easy and efficient methods for improving jaw mobility (Fig. 30-20).

Medication

Four types of medication have been widely used in the treatment of temporomandibular disorders: (1) NSAIDs, (2) occasional use of stronger analgesics, (3) muscular relaxants, and (4) tricyclic antidepressants.

NSAIDs not only reduce inflammation but also serve as an excellent analgesic. Some examples of NSAIDs are naproxen (Naprosyn), ibuprofen (Motrin), diflunisal (Dolobid), and piroxicam **(Feldene).** These medications can be effective in reducing inflammation in both muscles and joints and in most cases provide satisfactory pain relief. These drugs are not associated with severe addiction problems, and their use as an analgesic is strongly preferred over narcotic medications. It is important to remember that these medications work best when administered on a timetable rather than on a pain-dependent schedule. Patients should be instructed to take the medicine on a regular basis, obtaining an adequate blood level that should then be maintained for a minimum of 7 to 10 days. Discontinuation or tapering of the medicine can then be attempted.

The COX-2 inhibitors such as celecoxib (Celebrex) and rofecoxib (Vioxx) have gained popularity in the treatment of inflammation and pain. Prostaglandins produced by COX-1 activity appear to be required for normal physiologic function, whereas those produced by COX-2 activation mediate pain and inflammation. The COX-2 inhibitors are intended to reduce pain and inflammation without affecting prostaglandin-dependent functions. These drugs have been associated with significant side effects, including gastric and cardiac complications.

Analgesic medicines for TMJ patients may range from acetaminophen to potent narcotics. One important principle of treatment for all pain and dysfunction patients is to remember that the problem may be chronic and that medication could produce long-term addiction. Because of the sedative and depressive effects of narcotics and their potential for addiction, these medications should be restricted to short-term use in patients with severe, acute pain. In such instances medications such as acetaminophen with codeine should be sufficient. This medication should not be used for longer than 10 days to 2 weeks.

Muscle relaxants may provide significant improvement in jaw function and relief of masticatory pain. However, muscle relaxants have a significant potential for depression and sedation and can produce long-term addiction. In many patients with acute pain or exacerbation of muscular hyperactivity, muscle relaxants can be considered for short periods, such as 10 days to 2 weeks. The lowest effective dose should be used. Diazepam (Valium) 2 to 5 mg or cyclobenzaprine **(Flexeril)** 10 mg generally provides adequate relief of muscular symptoms in patients with TMD.

Tricyclic antidepressants in low doses appear to be useful in the management of patients with chronic pain. Tricyclic antidepressants prevent the reuptake of amine neurotransmitters, such as serotonin and norepinephrine, causing an inhibition of pain transmission. Recently, anecdotal evidence has suggested that these antidepressants may be effective in decreasing nocturnal bruxism. It appears that nighttime bruxing may be in part a result of disruption of normal sleep patterns. The use of amitriptyline (Elavil) in small doses (10 to 25 mg at bedtime) may improve sleep patterns, decrease bruxism, and result in decreased joint and muscle pain.

Medications that must be administered by injection may occasionally be helpful in managing muscular and joint pain and inflammation. Recently the use of Botulinum Toxin A has shown promise in decreasing masticatory muscle hyperactivity.[18,19] Botulinum Toxin (Botox) is a neurotoxin produced by the bacterium *Clostridium botulinum.* This neurotoxin produces a paralytic effect on muscles by inhibiting the release of acetylcholine at the neuromuscular junction. In very low doses, Botox can be safely administered by injection directly into the affected muscle area, decreasing muscle contraction activity and the associated pain. The effect of Botox is temporary, lasting from

FIG. 30-20 Jaw exercising device. Patient can use Therabite appliance to increase range of jaw motion.

a few weeks to several months. In many cases injection of Botox must be repeated to obtain long-term pain relief.

Injection of steroids directly into the joint has been suggested as an effective way to decrease pain and inflammation, because these compounds are known to inhibit proinflammatory cytokines.[20] There continues to be some debate about the long-term effect of steroids in the joint and the possibility that further degeneration may be associated with steroid injection.[21] Further research is required in this area.

Physical Therapy

Physical therapy can be extremely useful in the management of patients with temporomandibular pain and dysfunction. The most common modalities used include EMG biofeedback and relaxation training, ultrasound, spray and stretch, and pressure massage.

Relaxation training, although perhaps not physical therapy in the strictest sense, can be extremely effective in reducing symptoms caused by muscular pain and hyperactivity. During the educational phase, patients are made aware of the contribution of stress and muscular hyperactivity to pain. Relaxation techniques can be used to reduce the effects of stress on muscle and joint pain. EMG monitoring of the patient's muscular activity can be used as an effective teaching tool by providing instant feedback demonstrating relaxation therapy, reduction of muscular hyperactivity, and the resultant improvement in symptoms of pain.

Ultrasound is an effective way to produce tissue heating with the use of ultrasonic waves, which alter blood flow and metabolic activity at a deeper level than that provided by simple surface moist-heat applications.[22] The effect of ultrasonic tissue heating is theoretically related to increase in tissue temperature, increase in circulation, increase in uptake of painful metabolic by-products, and disruption of collagen cross-iinking, which may affect adhesion formation. All of these effects may result in a more comfortable manipulation of muscles and a wider range of motion. In addition, intraarticular inflammation may also be reduced with ultrasonic applications. Ultrasonic treatments are usually provided by a physical therapist in combination with other treatment modalities. The typical routine for application of ultrasound is the use of 0.7 to 1.0 watts per cm^2 applied for approximately 10 minutes over the affected areas (i.e., temporalis and masseter muscles and TMJ) (Fig. 30-21). Ultrasonic treatments are most effective when repeated every other day or every third day for several consecutive treatments.

Spray and stretch is an effective method for improving range of motion. The theory behind spray and stretch is the concept that stimulating large cutaneous nerve fibers can produce an overriding or distracting effect on pain input from smaller fibers that originate in the muscles and joints.[23] By spraying a vapocoolant material, such as fluormethane, over the lateral surface of the face, the muscles of mastication can be passively or actively stretched with a reduced level of pain (Fig. 30-22).

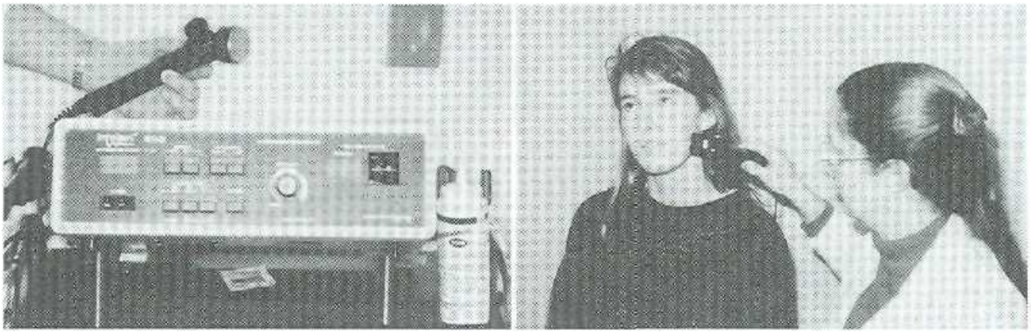
Friction massage involves the use of firm cutaneous pressure sufficient to produce a temporary degree of ischemia. This ischemia and the resultant hyperemia have been described as a method for inactivation of trigger points, which are areas responsible for pain referred to muscles in the head and neck area.[23] More frequently this technique may be useful in disrupting small fibrous connective tissue adhesions that may develop within the muscles during healing after surgery and injury or as a result of prolonged muscular shortening from restricted motion.

Physical therapists and other practitioners sometimes use transcutaneous electronic nerve stimulation (TENS) to provide pain relief for chronic pain patients when other techniques have been unable to eliminate or reduce pain symptoms (Fig. 30-23).

The exact mechanism of action of TENS is not completely understood. The technique was initially based on the concept that stimulation of superficial nerve fiber with TENS may be responsible for overriding pain input from structures such as masticatory muscles and the TMJs. Interestingly, many patients who use TENS units experience pain relief that is longer in duration than the time during which the unit is actually applied. This may be a result of the release of endogenous endorphin compounds that can provide extended periods of decreased pain.

Each of the physical therapy modalities may be extremely useful in initial attempts to reduce TMJ pain and increase range of motion. The low cost of physical therapy compared with other medical treatment, the likelihood that some benefit will occur, and the minimal risk associated with these techniques are strong arguments for frequent use of physical therapy in the management of patients with TMD.

A



B

FIG. 30-21 A, Ultrasound unit for temporomandibular joint and facial pain physical therapy. B, Application of ultrasound to masseter muscle area.

Splints

Occlusal splints are generally considered a part of the reversible or conservative treatment phase in the management of TMD patients. Splint designs vary; however, most splints can be classified into two distinct groups: (1) autorepositioning splints and (2) anterior repositioning splints.

Autorepositioning splints. The autorepositioning splints, also called *anterior guidance splints, superior repositioning splints*, or *muscle splints*, are most frequently used to treat muscle problems or eliminate TMJ pain when no specific internal derangement or other obvious pathology can be identified. However, these splints may be used in some cases, such as anterior disk displacement or DJD, in an attempt to unload or reduce the force placed directly on the TMJ area. Nitzan has shown that properly designed splints can be effective in reducing intraarticular pressure.[12] The splint is usually designed to provide full-arch contact without working or balancing interferences and without ramps or deep interdigitation, which would force the mandible to function in one specific occlusal position (Fig. 30-24). This splint allows the patient to seek a comfortable muscle and joint position without excessive influence of the occlusion. An example of this type of splint would be in a patient with a class II malocclusion and significant overjet who continually postures forward to obtain incisor contact during mastication. Many of these patients complain of muscular symptoms and describe a feeling that they do not have a consistent, repeatable bite relationship. Wearing an autorepositioning splint allows full-arch dental contact with the condyles in a more posterior retruded position, which frequently results in reduction in muscle and joint symptoms.

Anterior repositioning splints. Anterior repositioning splints are constructed so that an anterior ramping effect forces the mandible to function in a protruded position (Fig. 30-25). This type of splint is most useful in providing temporary relief and, in rare cases, a long-term

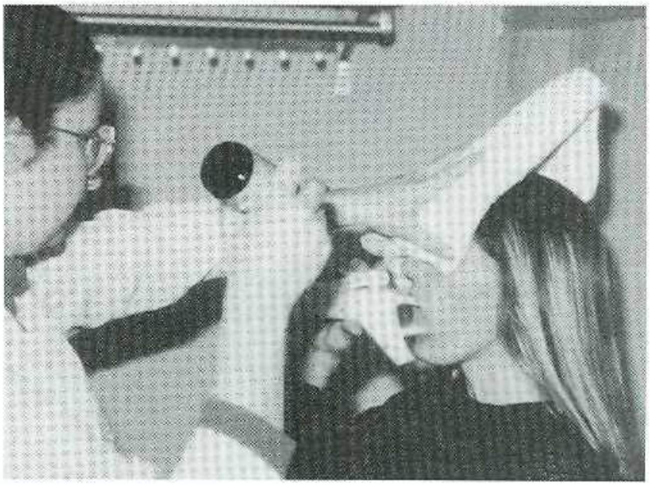
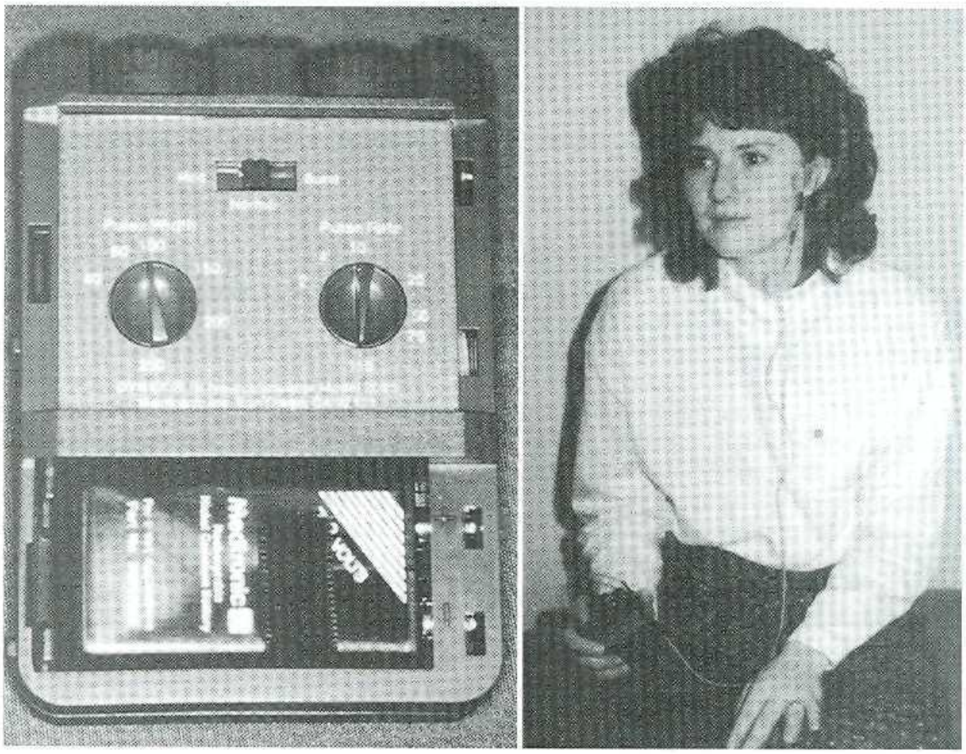


FIG. 30-22 Spray-and-stretch technique. Vapocoolant is applied while patient performs increased range-of-motion exercises using Therabite appliance.

A



B

FIG. 30-23 Transcutaneous electronic nerve stimulation. **A, Unit used** for applying electrical stimulation to face. B, Placement of electrodes over masseter muscle area for application of electric stimulus.

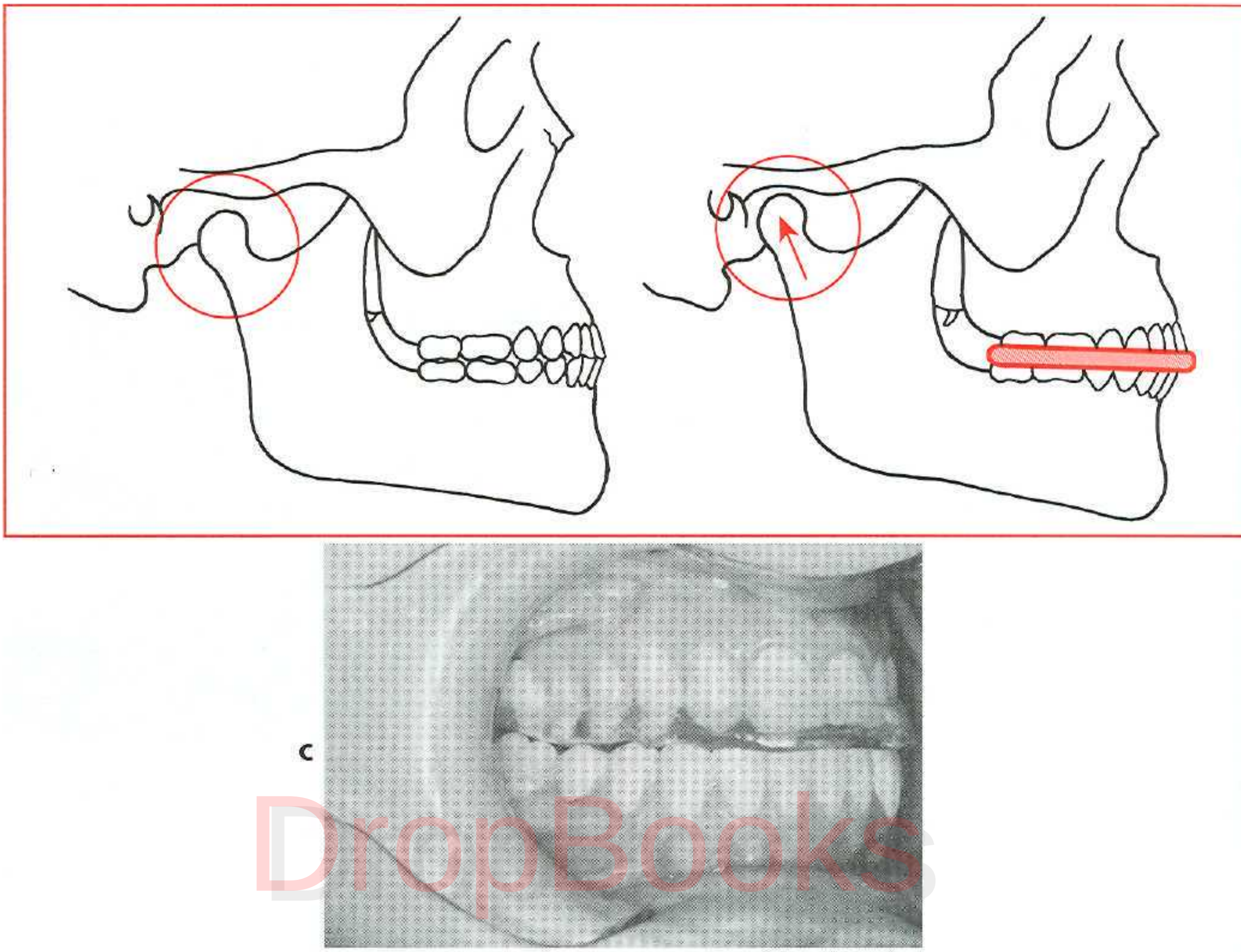


FIG. 30-24 Autorepositioning splint. A, Diagram representing maximum interdigitation obtained with condyle slightly down and forward. B, Repositioning of mandible by eliminating forced interdigitation of teeth results in posterior and superior repositioning of condyle. C, Clinical photograph of autorepositioning splint.

cure for anterior disk displacement with reduction. In these cases the anterior position is determined by protrusion of the mandible necessary to produce the proper disk and condyle relationships (after the protruding or opening click has occurred).

The splint is usually worn 24 hours a day for several months. Theoretically after the disk is repositioned for a long period, the posterior ligaments may shorten and maintain the disk in proper relationship to the condyle. Despite theoretical expectations, these splints are generally ineffective in producing permanent reduction of disk displacement. However, even when the splints are not curative, they often provide significant relief of discomfort in the acute stages of TMJ dysfunction.

PERMANENT OCCLUSION MODIFICATION

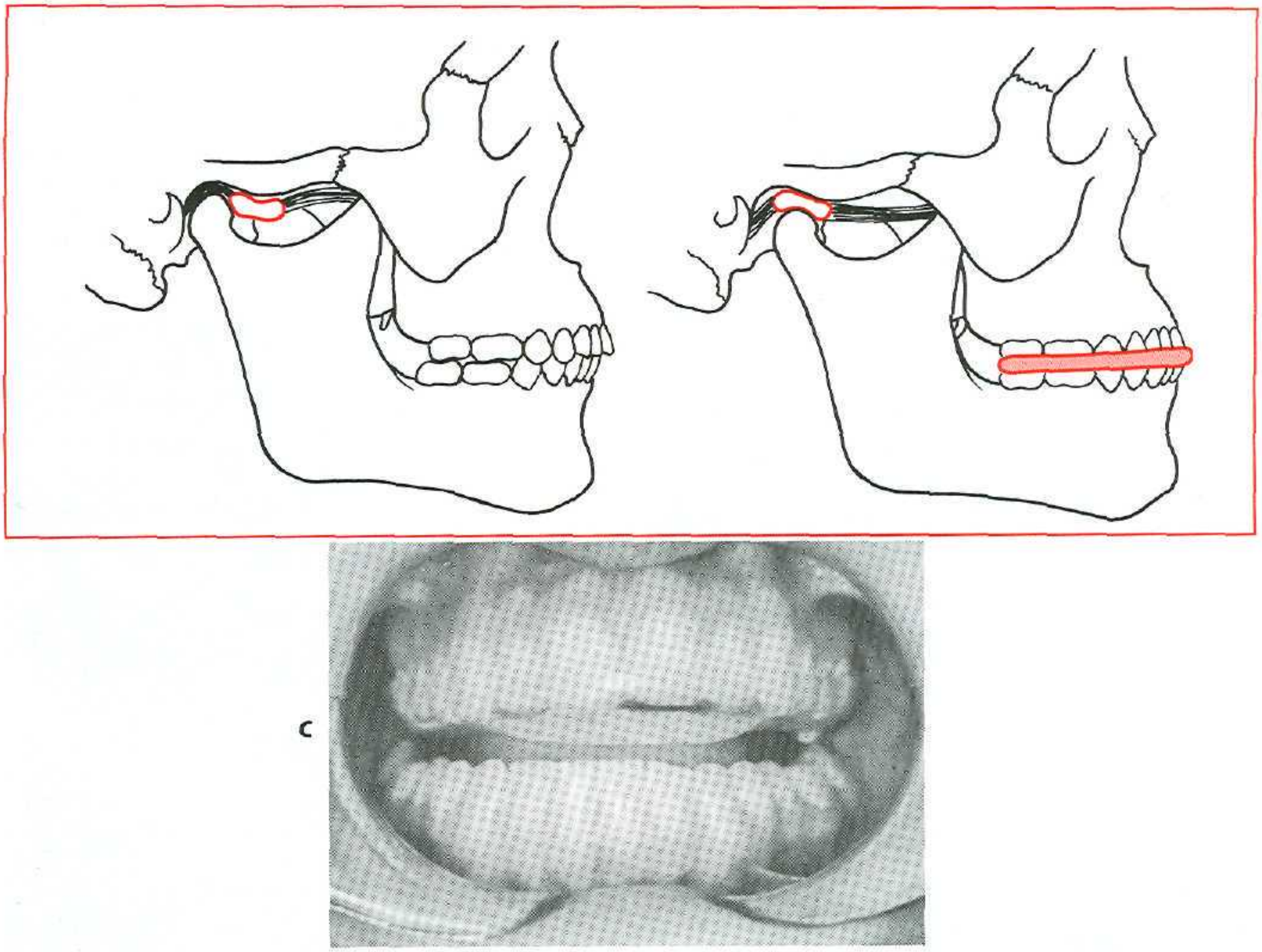
After completion of a course of reversible treatment, many patients may be candidates for permanent modification of the occlusion. This permanent modification appears to be most appropriate when patients have had significant improvement in masticatory function and reduction in pain as a result of temporary alteration of occlusal position with splint therapy. Permanent occlusion modification may include occlusal equilibration, prosthetic restoration, orthodontics, and orthognathic surgery. Although the relationship between occlusion abnormalities and TMD is unclear, it does appear that permanent modification of the occlusion in indicated patients may provide long-term improvement in symptoms of pain and dysfunction.

TEMPOROMADIBULAR JOINT SURGERY

Despite the fact that many patients with internal joint pathology will improve with reversible nonsurgical treatment, some patients will eventually require surgical intervention to improve masticatory function and decrease pain. Several techniques are currently available for correction of a variety of TMj derangements.

A

B



C

FIG. 30-25 Anterior repositioning splint. A, Diagram of anteriorly displaced disk. B, Disk interposition between condyle and articular eminence, with anterior repositioning splint in place. Anterior position of mandible allows function with condyle in appropriate condyle and disk relationship. C, Clinical photograph of anterior repositioning splint.

Arthrocentesis

Arthrocentesis involves placing needles into the TMJ and therefore is not actually a surgical procedure. However, because it is somewhat invasive and generally performed by oral and maxillofacial surgeons, it is discussed here.

Most patients undergoing arthrocentesis do so with local anesthesia and intravenous (IV) sedation. Several techniques have been described for TMJ arthrocentesis.[10,24] The most common method involves initially placing one needle into the superior joint space. A small amount of lactated Ringer's solution is injected to distend the joint space and can then be withdrawn and evaluated for diagnostic purposes, if desired. The joint is redistended, and a second needle is placed into the superior joint space. This allows larger amounts of fluid (approximately 200 ml) to lavage the joint.

During the arthrocentesis the jaw can be gently manipulated. At the conclusion of the procedure, steroids, local anesthesia, or a combination of both can be injected into the joint space before the needles are withdrawn. Discomfort after the procedure is managed with mild analgesics or NSAIDs. Some type of exercise regimen or physical therapy is accomplished during the recovery period.

Many types of internal joint pathology appear to respond well to arthrocentesis. The most common use appears to be in patients with anterior disk displacement without reduction. Treatment appears to be very effective, with results similar to or better than other types of arthroscopic and open surgical procedures. Nitzan demonstrated that arthrocentesis produced significant improvement in incisal opening and reduction of pain in patients with persistent and severe closed lock.[24]

The success seen with arthrocentesis has several potential explanations. When disk displacement occurs, negative pressure may develop within the joint, causing a "suction cup" effect between the disk and fossa. Distending the joint obviously eliminates the negative pressure. In some cases of more chronic disk displacement, some

adhesion may develop between the disk and fossa. With arthrocentesis the distension under pressure can release these adhesions. Capsular constriction may occur as a result of joint hypomobility and can be stretched with pressure distension. Finally, there may be an accumulation of some of the chemical mediators described previously. The simple flushing action in the joint may eliminate or decrease biochemical factors contributing to inflammation and pain.

Arthroscopy

Arthroscopic surgery has become one of the most popular and effective methods of diagnosing and treating TMJ disorders.[25] This technique involves placement of a small cannuia into the superior joint space. An arthroscope with light source is then inserted through the cannula into the superior joint space (Fig. 30-26). The arthroscope is then connected to a video camera and monitor, which allow excellent visualization of all aspects of the glenoid

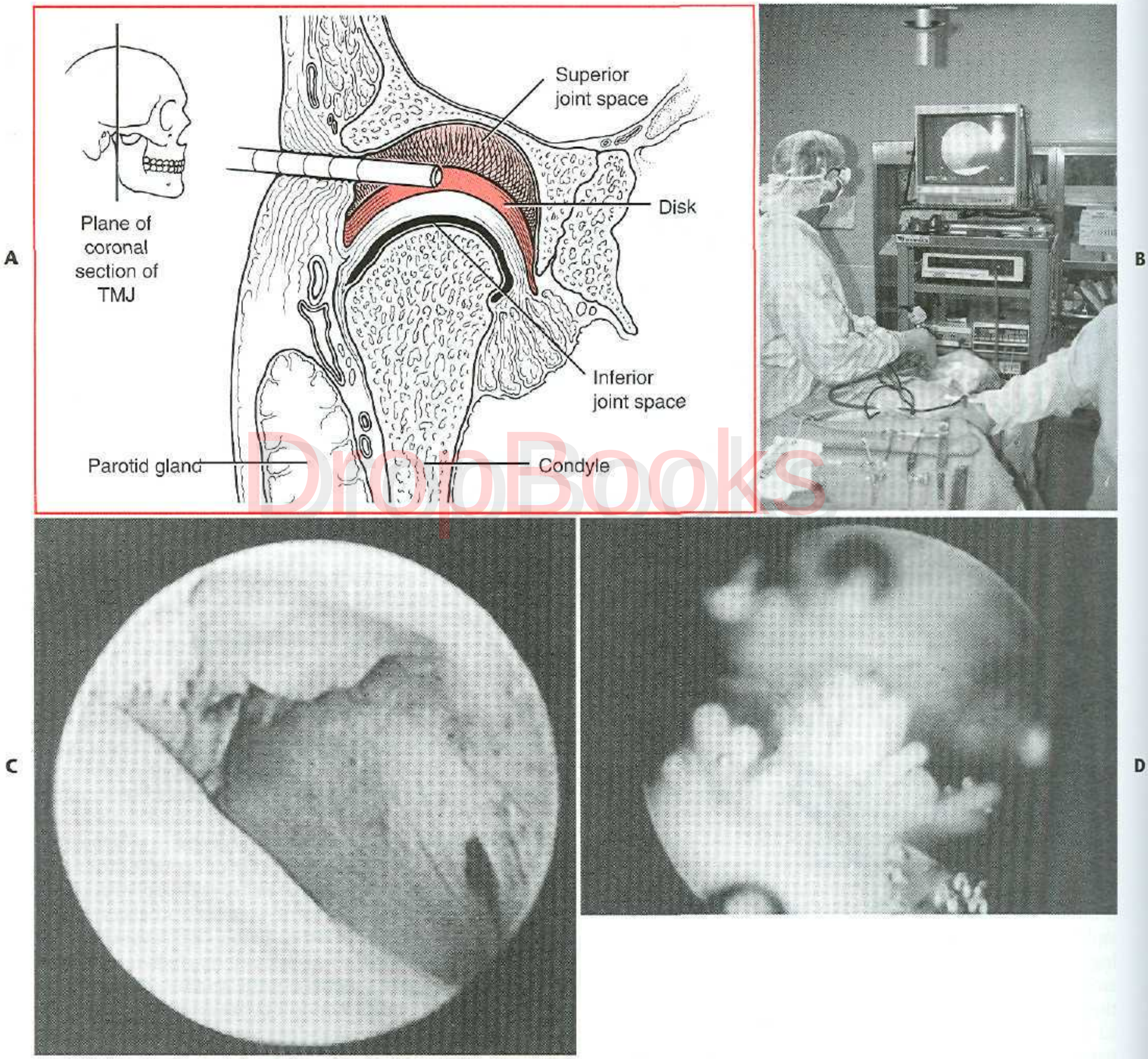


FIG. 30-26 A, Arthroscope placed in superior joint space. B, Operating room set up for arthroscopy. C, View of superior joint space. Interiorly, disk tissue can be clearly visualized. Superiorly, fibrous tissue covering fossa is disrupted as result of separation of adhesions with arthroscopic surgical techniques. D, Close-up view of synovial tissue hypertrophy.

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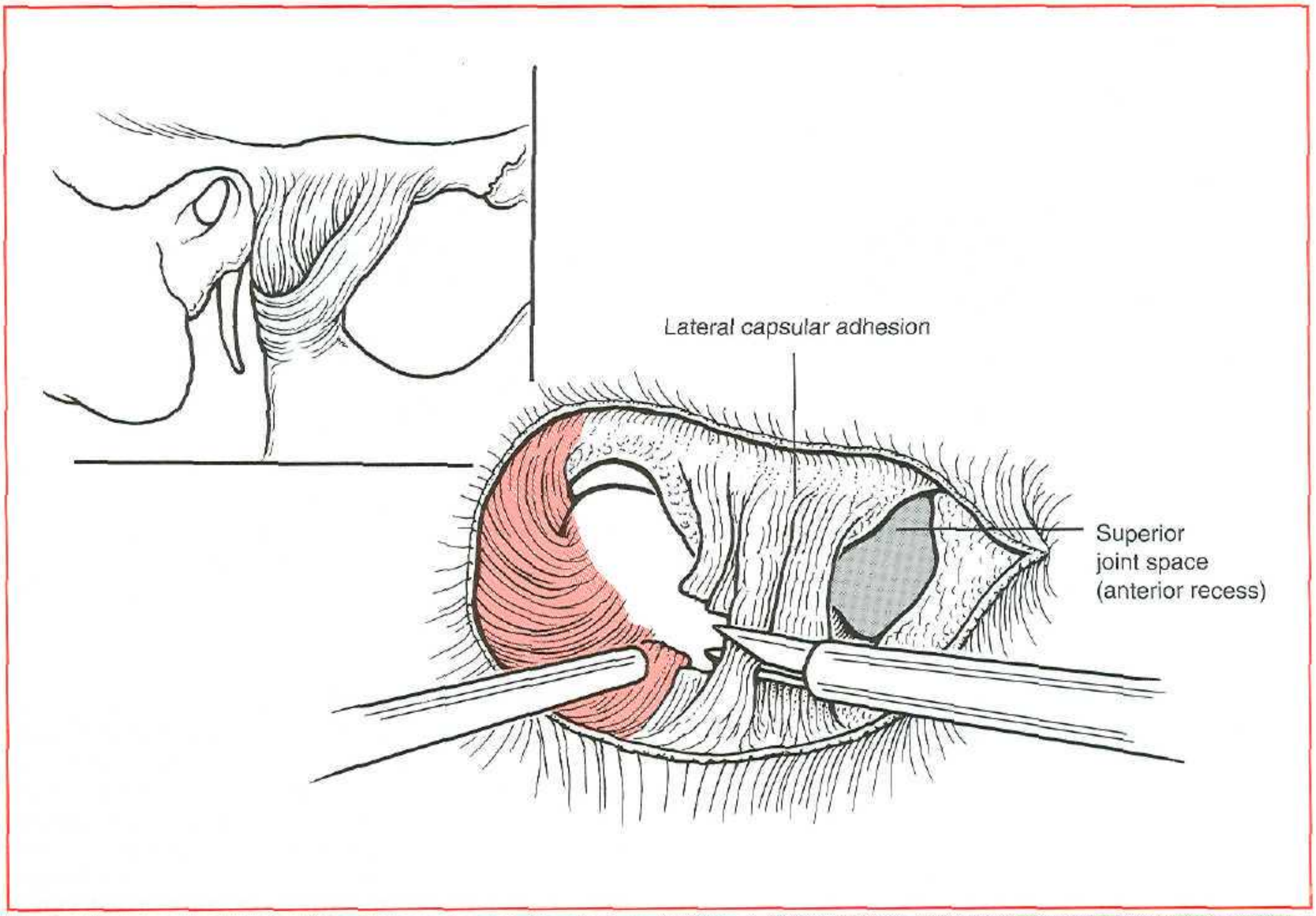

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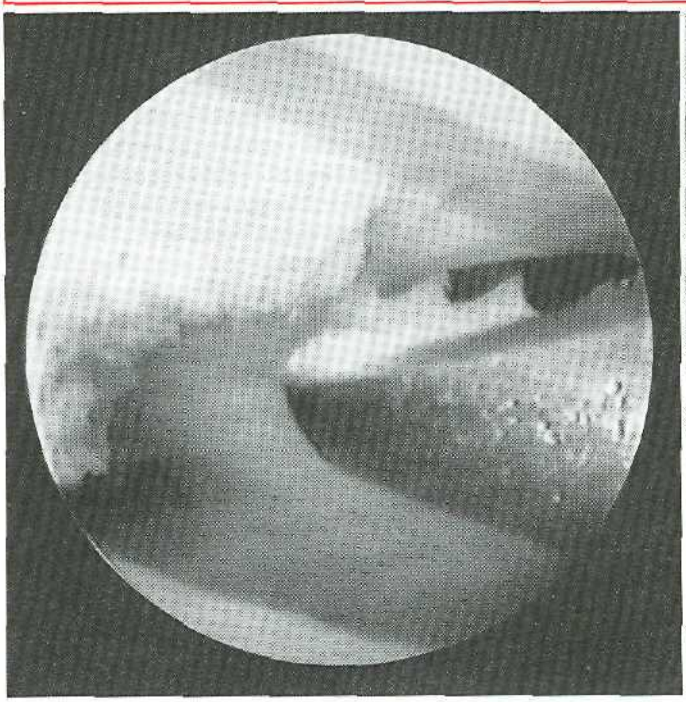
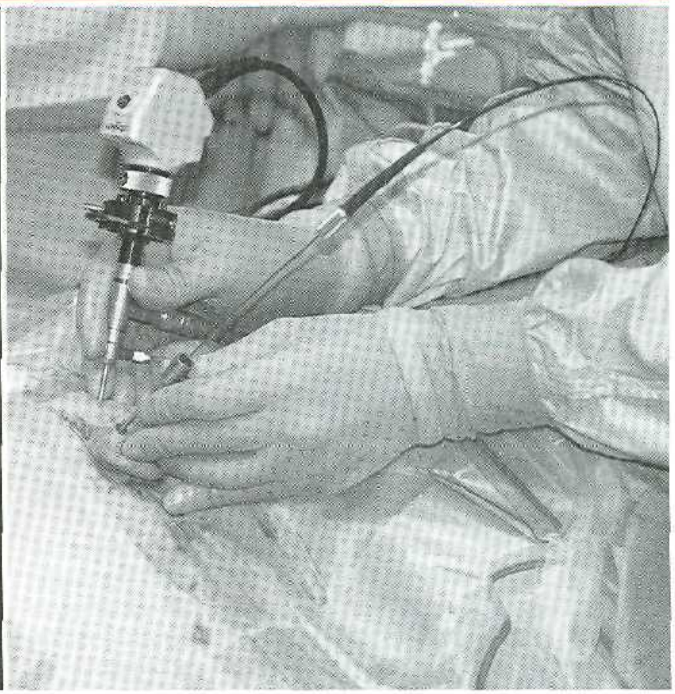
F





G

FIG. 30-26—cont'd E, Diagram of arthroscope and working cannula using surgical microscissors placed through cannula to cut fibrous band. F, View through arthroscope of motorized shaver used to remove fibrous tissue from articular surface. G, Arthroscopic surgery using laser fiber inserted through working cannula.

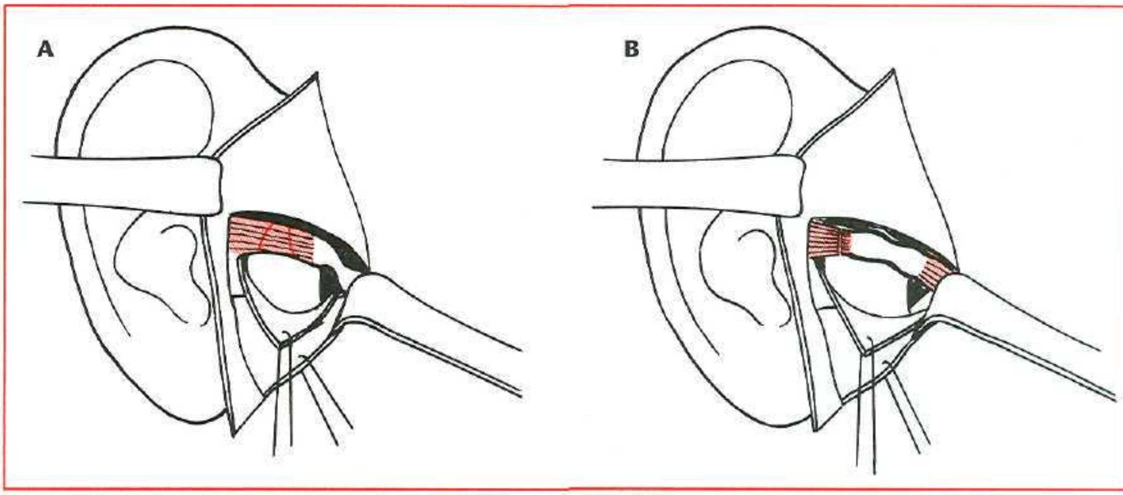


FIG. 30-27 Open temporomandibular joint (TMJ) surgical procedure to replace displaced disk. A, Preauricular incision through skin subcutaneous tissue and TMJ capsule, exposing anteriorly displaced disk. B, Wedge of tissue is removed from posterior attachment area, and disk is repositioned and sutured into its correct position.

fossa and superior aspect of the disk. Initial arthroscopic techniques are limited primarily to visualization of the joint for diagnostic purposes and lysis of fibrous joint adhesions, combined with lavage of the joint.

More sophisticated arthroscopic operative techniques have been developed, increasing the ability of the surgeon to correct a variety of intracapsular disorders. Current surgical techniques usually involve the placement of at least two cannulas into the superior joint space. One cannula is used for visualization of the procedure with the arthroscope, while instruments are placed through the other cannula to allow instrumentation in the joint (Fig. 30-26, *E* through G). Instrumentation used through the arthroscope includes forceps, scissors, sutures, medication needles, cautery probes, and motorized instrumentation, such as burs and shavers. Laser fibers can also be used to eliminate adhesions and inflamed tissue and incise tissue within the joint. Disk manipulation, disk attachment release, posterior band cautery, and suture techniques have been developed in an attempt to reposition or stabilize displaced disks.[26] Although it appears that attempts to reposition displaced disks do not result in anatomic restoration of normal disk position, patients undergoing this type of treatment appear to have significant clinical improvement after arthroscopic surgery.[27]

Arthroscopic surgery has been advocated for treatment of a variety of TMJ disorders, including internal derangements, hypomobility as a result of fibrosis or adhesions, DJD, and hypermobility. The efficacy of arthroscopic treatment appears to be very similar to that of open joint procedures, with the advantage of less surgical morbidity and fewer and less severe complications.[25,28]

As with most TMJ surgical procedures, patients are placed on some type of physical therapy regimen after

Disk-Repositioning Surgery

During the late 1970s and 1980s one of the most commonly performed TMJ surgical procedures was disk repositioning and plication. The indication for this procedure is anterior disk displacement that has not responded to nonsurgical treatment and that most frequently results in persistent painful clicking joints or closed locking (i.e., anterior disk displacement with or without reduction). Although these disorders are more frequently managed surgically with arthrocentesis or arthroscopy, many surgeons still prefer this type of surgical correction. In this operation the displaced disk is identified and repositioned into a more normal position by removing a wedge of tissue from the posterior attachment of the disk and suturing the disk back to the correct anatomic position (Fig. 30-27). In some cases this procedure is combined with recontouring of the disk, articular eminence, and mandibular condyle. After surgery, patients generally begin a nonchew diet for several weeks, progressing to a relatively normal diet in 3 to 6 months. A progressive regimen of jaw exercises is also instituted in an attempt to obtain normal jaw motion within 6 to 8 weeks after surgery.

In general the results of open arthroplasty have been good, with 80% to 95% of the patients experiencing less pain and improved jaw function.[29] Unfortunately this surgery does not produce improvement in all patients, with 10% to 15% of patients describing no improvement or a worsening of the condition.

Disk Repair or Removal

In some cases the disk is so severely damaged that the remnants of disk tissue must be removed. Diskectomy without replacement was one or the earliest surgical procedures described for treatment of severe TMJ internal derangements.[30] With current technology, the diskectomy procedure can be performed through arthro-

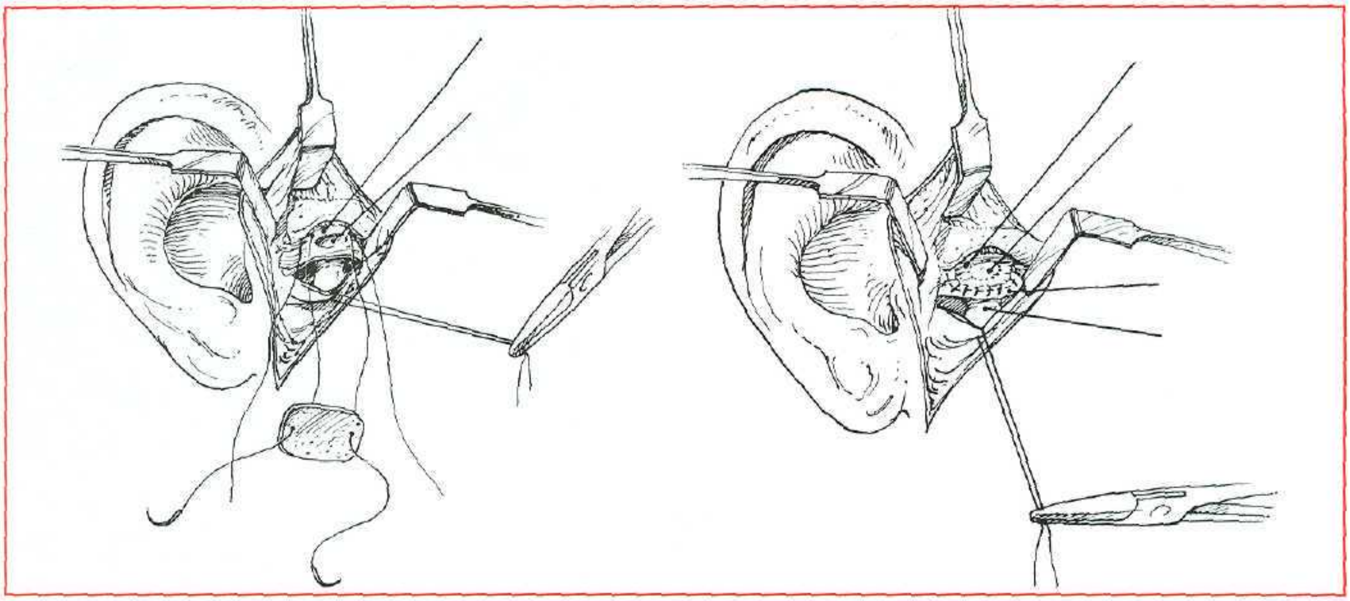


FIG. 30-28 Dermal graft used to patch small perforation of disk.

scopic techniques described earlier. Although this technique has been widely used, there seems to be a wide variation in clinical results, with some joints showing minimal anatomic changes and significant clinical improvement to joints that demonstrate severe degenerative changes with continued symptoms of pain and dysfunction.

In advanced internal joint pathology, the disk may be severely damaged and perforated but may have adequate remaining tissue so that a repair or patch procedure can be accomplished (Fig. 30-28). A variety of autogenous tissue sources have been used for disk repair, including grafts of dermal or fascial tissue.[31]

In many cases the disk was previously replaced with alloplastic implant material. However, significant failures have been seen with many of these implant materials, including implant fragmentation, foreign-body reaction, synovitis, and gross erosion of bony articular surfaces. These problems led to a renewed interest in autogenous tissue replacement after disk removal. Autogenous grafting techniques include the use of auricular cartilage, temporalis fascia, and the combination of muscle and fascial flaps (Fig. 30-29).[32] Although well-done long-term studies of the outcome of each of these techniques are limited, most patients realize some degree of improvement in pain and function after treatment with these procedures,

Condylotomy for Treatment of Temporomandibular joint Disorders

The condylotomy is an osteotomy completed in a manner identical to the vertical ramus osteotomy described in Chapter 25. When used for treatment of TMJ problems the osteotomy is completed, but no wire or screw fixation is placed, and the patient is placed into intermaxillary fixation for a period ranging from 2 to 6 weeks. The theory behind this operation is that muscles attached to the proximal segment (i.e., segment attached to the condyle) will passively reposition the condyle, resulting in a more favorable relationship between the condyle, disk, and fossa.[33]

This technique has been advocated primarily for treatment of disk displacement with or without reduction. DJD and subluxation or dislocation have also been suggested as possible indications for use of this technique. Although this method of surgical treatment has been somewhat controversial, it appears to provide significant clinical improvement in a variety of TMJ disorders.

Total Joint Replacement

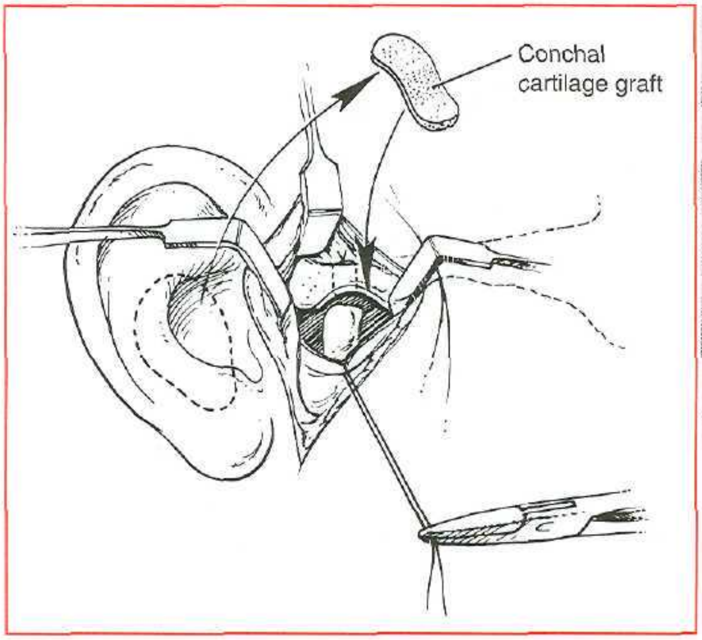
In some cases, joint pathology results in destruction of joint structures so that reconstruction or replacement of components of the TMJ is necessary (Fig. 30-30, A).

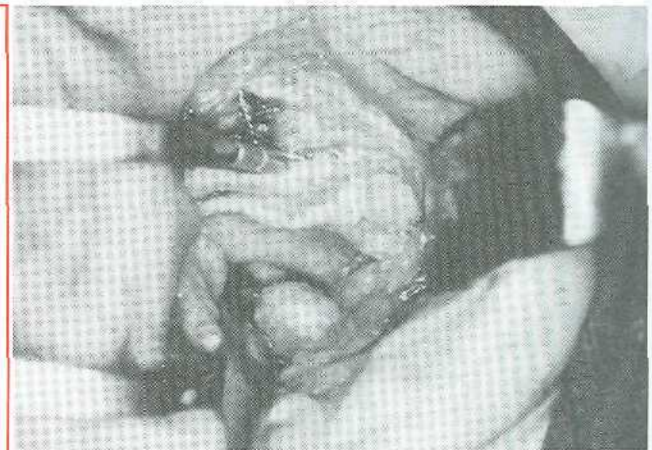
Examples of such situations include severe degenerative or rheumatoid arthritic disorders, severe cases of ankylosis, neoplastic pathology, posttraumatic destruction of joint components, and multiple failed surgical procedures. Surgical techniques may involve replacement of the condyle or fossa but most commonly include both elements.

One method of joint reconstruction involves grafting autogenous tissue using a costochondral bone graft.-[34] These grafts are most frequently used in growing individuals but also can be used effectively in the treatment of a variety of adult disorders. Figure 30-30, *B* shows the use of a costochondral graft for replacement of a severely degenerated mandibular condyle. In this situation the graft replaces only the condylar portion of the joint and does not address significant abnormalities of the fossa.

Problems with costochondral grafting include recurrent ankylosis, degenerative changes of the graft, and (in some cases) excess and asymmetric growth of the graft.

A

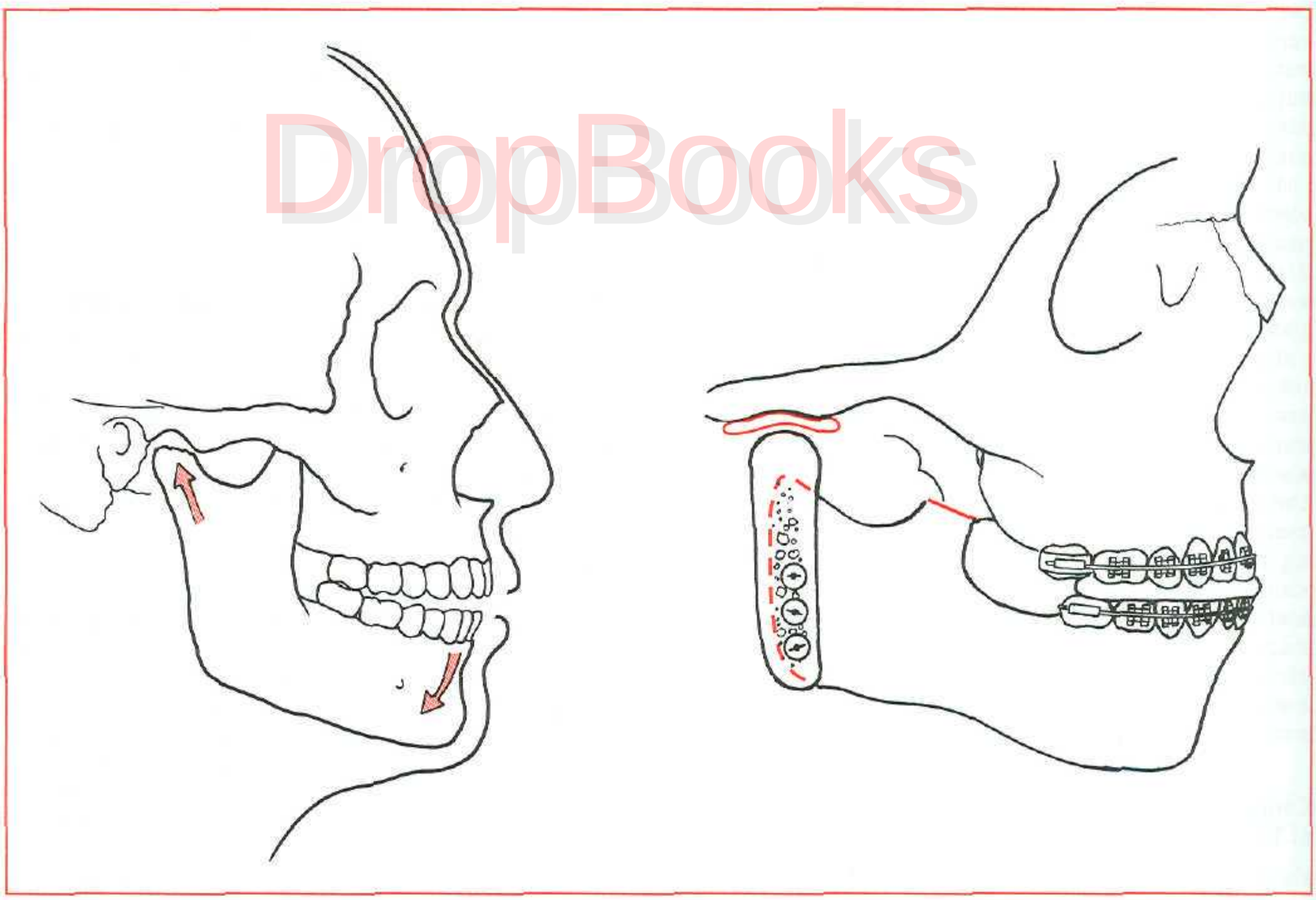




B

FIG. 30-29 A, Diagram of auricular cartilage harvested from inferior portion of ear, used as a graft material in temporomandibular joint after removal of disk tissue. B, Clinical photograph.

A



B

FIG- 30-30 Total joint replacement. A, Severe degeneration of condyle, resulting in malocclusion, pain, and limited opening. B, Costochondral bone graft placed along posterior aspect of mandible to reconstruct severely damaged condyle. Tissue grafts or alloplastic implants can be used as disk replacement technique in combination with costochondral grafting.

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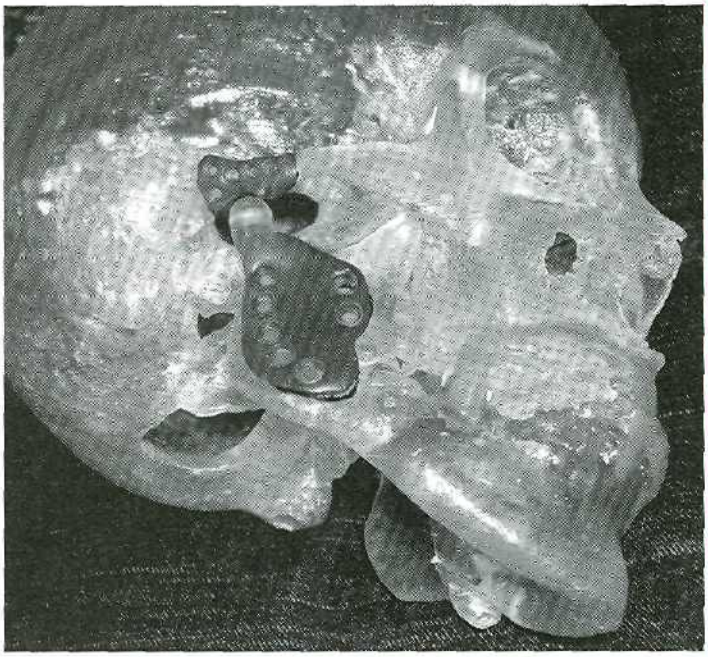
C



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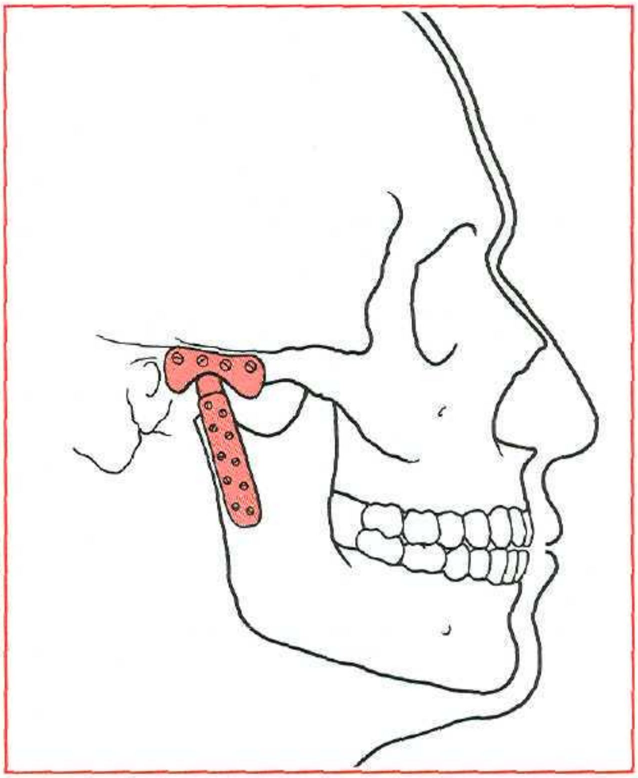

FIG. 30-30—cont'd **C,** Stereolithic model with wax pattern for custom temporomandibular joint condyle and fossa replacement. D, Diagrammatic representation of total joint reconstruction with prosthetic replacement of both condyle and fossa components.

In the past several types of prosthetic joint replacement have been available.[35] Long-term results of prosthetic joint replacements have been somewhat disappointing because of a variety of technical and biologic problems. However, for many patients with significant destruction of TMJ structures who have had poor results from other surgical treatment, no other viable surgical options exist. In these cases the joint destruction results in severe pain, limited motion or complete ankylosis, and severe malocclusions (see Fig. 30-30, A). Current technologic advances include the use of three dimensional (3-D) reconstructed stereolithic models and custom fabrication of a total joint prosthesis, including the fossa and condyle (Fig. 30-30, C and *D).* These recent advantages have provided significant improvement in the outcome after total joint replacement.[36,37]

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